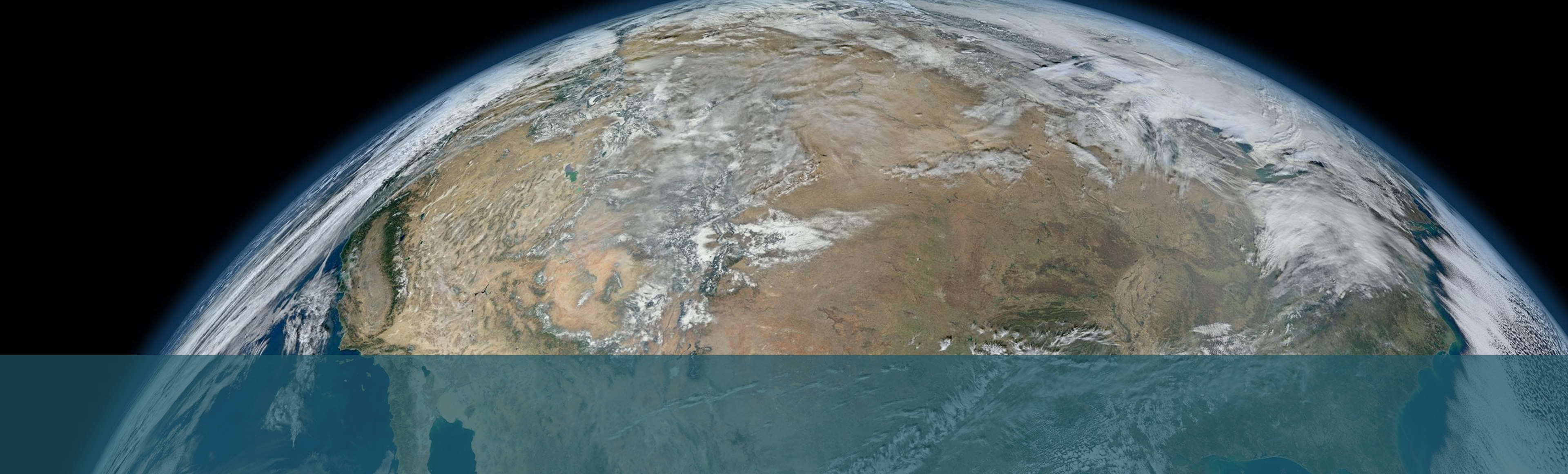
Climate and Your Community

February 23, 2023

Doug Kluck
Central Region Climate Services Director
NOAA National Center for Environmental Information

Adele Phillips, CFM
Flood Mitigation Planner
Nebraska Department of Natural Resources

NEBRASKA
DEPT. OF NATURAL RESOURCES



The Changing Climate, Extremes, Outlooks And Nebraska

Doug Kluck

Regional Climate Services Director

NOAA's National Centers for Environmental Information

Doug.kluck@noaa.gov

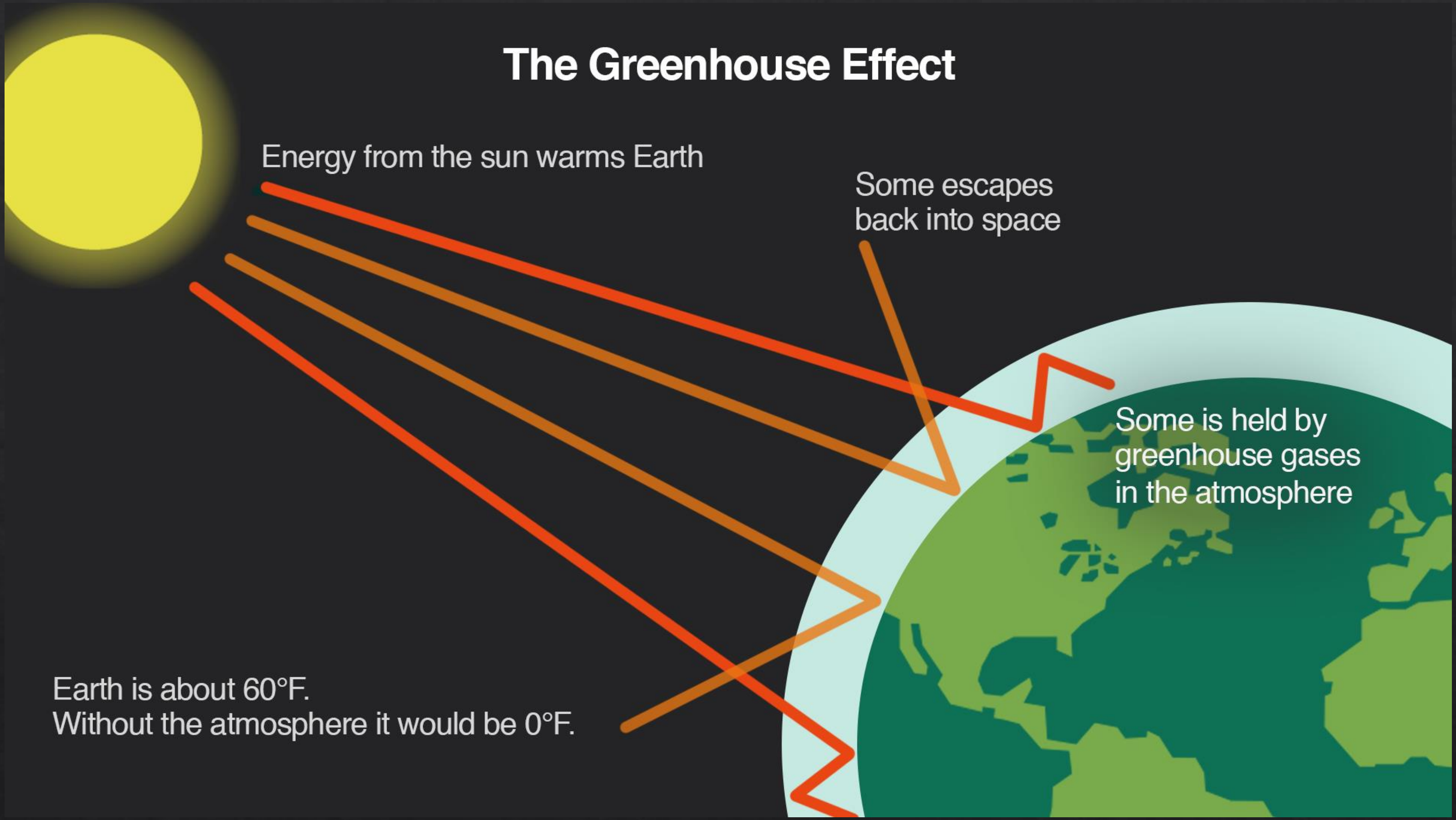
816-564-2417

February 23, 2023

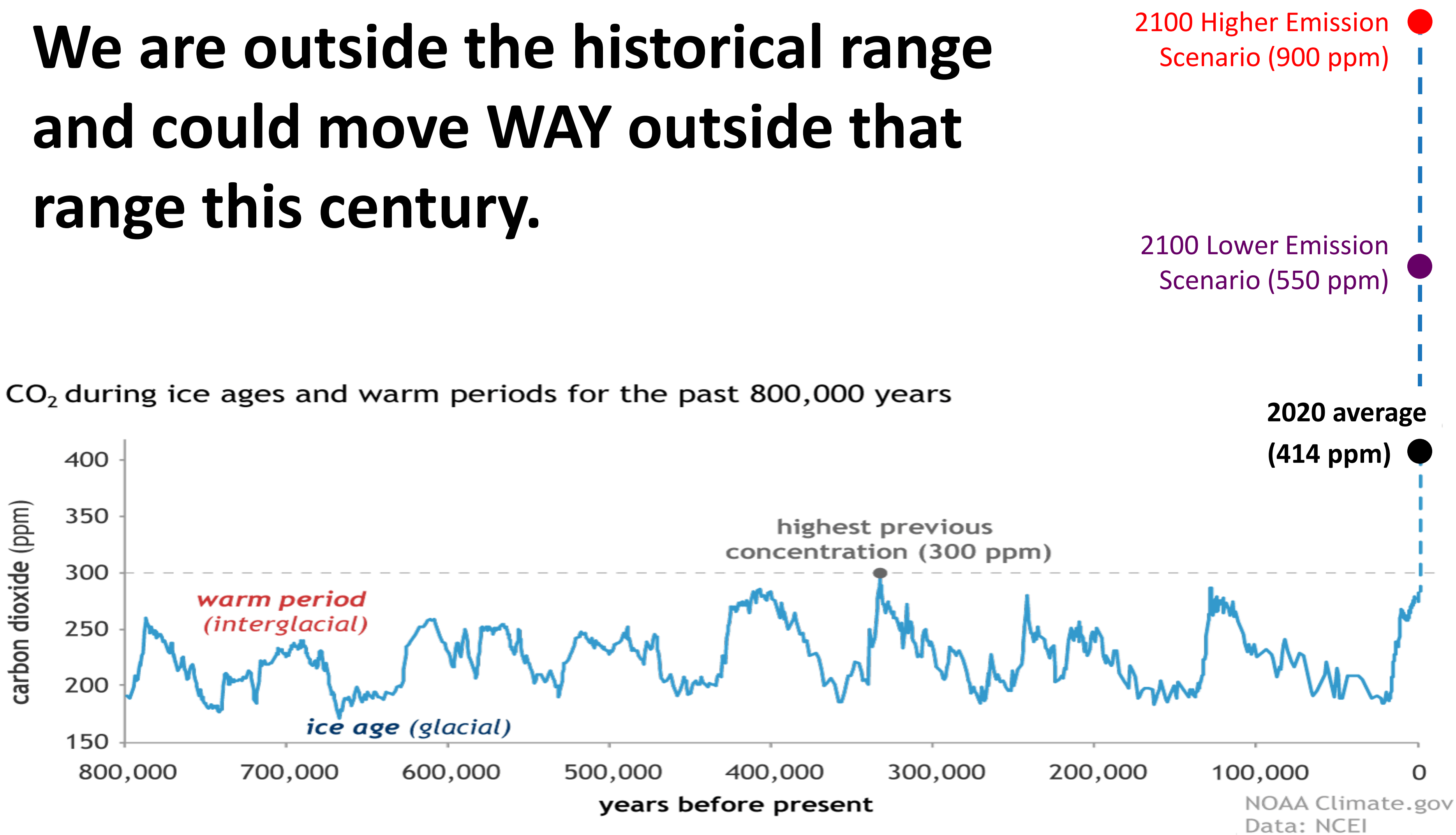
Agenda

- Changing Climate
- Extremes
- Impacts
- Trends/Current
- Outlooks

Science: Greenhouse Effect



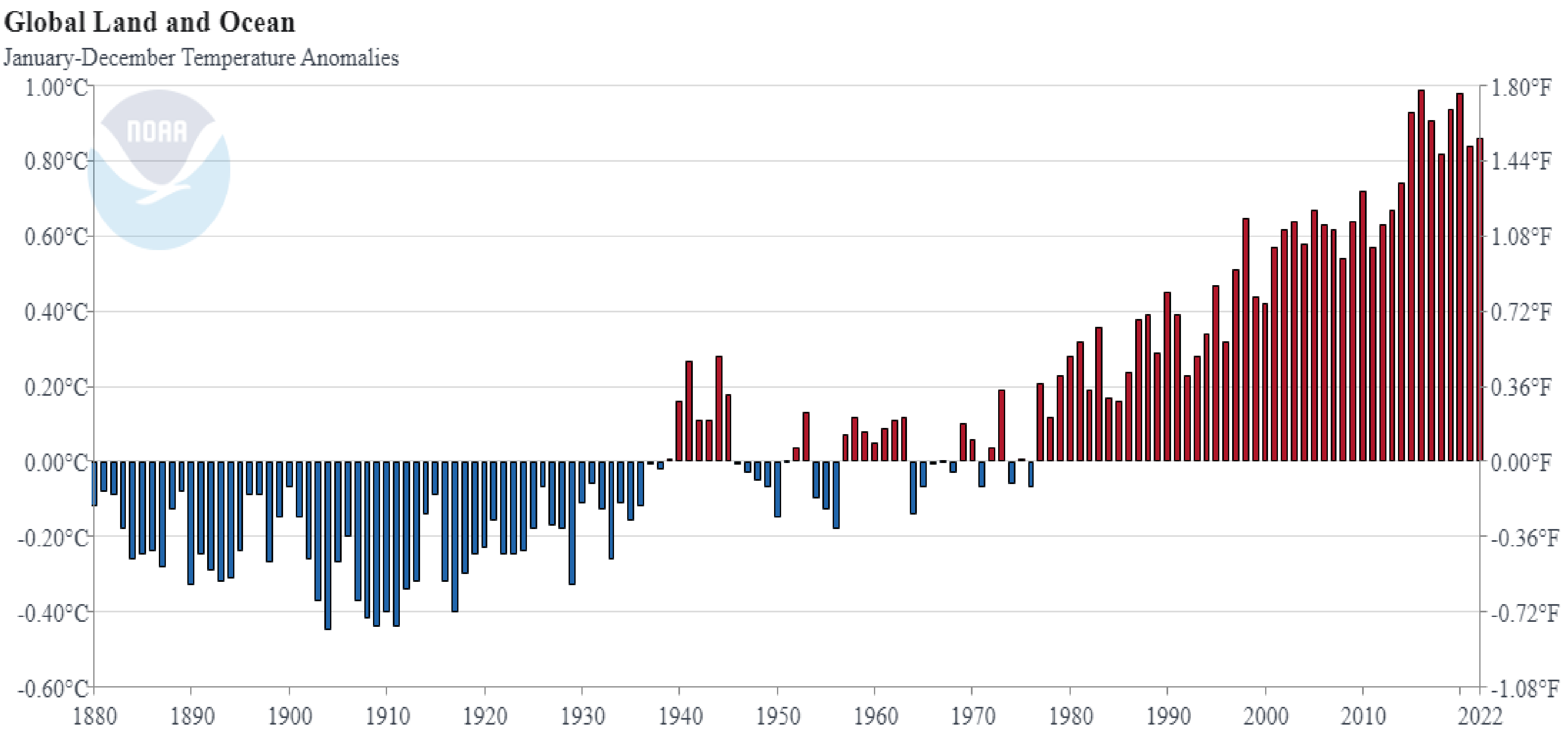
We are outside the historical range and could move WAY outside that range this century.



The Ten Warmest Years Globally (1880–2022)

Rank 1 = Warmest Period of Record: 1880–2022	Year	Anomaly °C	Anomaly °F
1	2016	0.99	1.78
2	2020	0.98	1.76
3	2019	0.94	1.69
4	2015	0.93	1.67
5	2017	0.91	1.64
6	2022	0.86	1.55
7	2021	0.84	1.51
8	2018	0.82	1.48
9	2014	0.74	1.33
10	2010	0.72	1.30

Global Temperatures (1880 – 2022)



https://www.ncdc.noaa.gov/sotc/

How does the climate in 2022 rank?

2022 was the 18th warmest year on record for the U.S.

2022 was the 6th warmest year on record for the globe

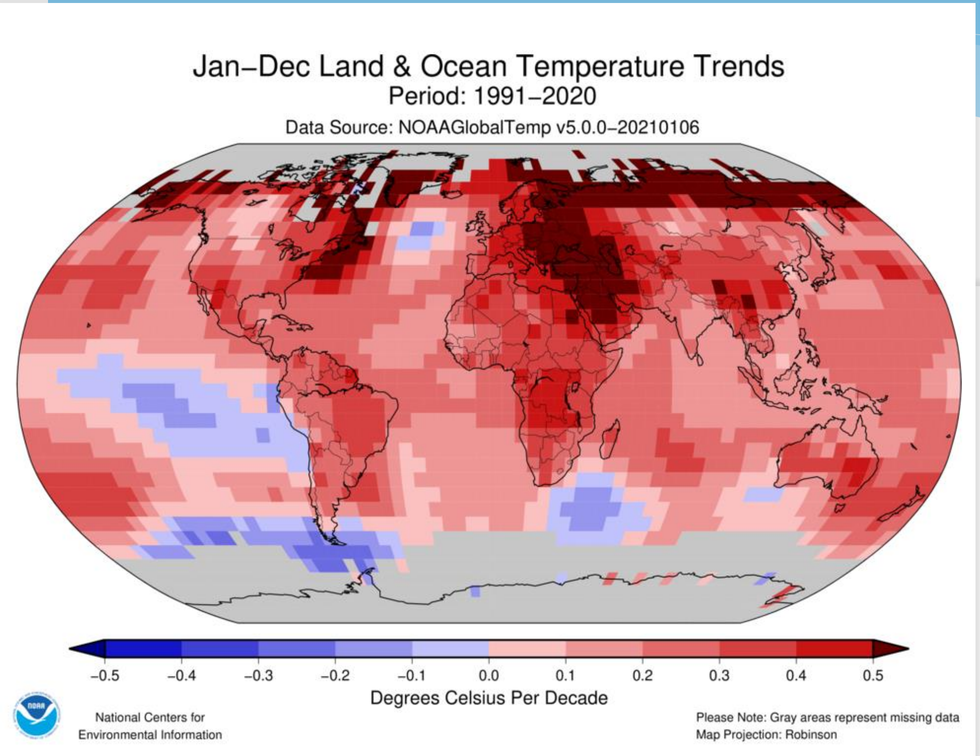
2010-2022 top 10 warmest years globally since 1880

2022 global ocean heat content 6th highest on record

2015-2022 eight highest ocean heat content years

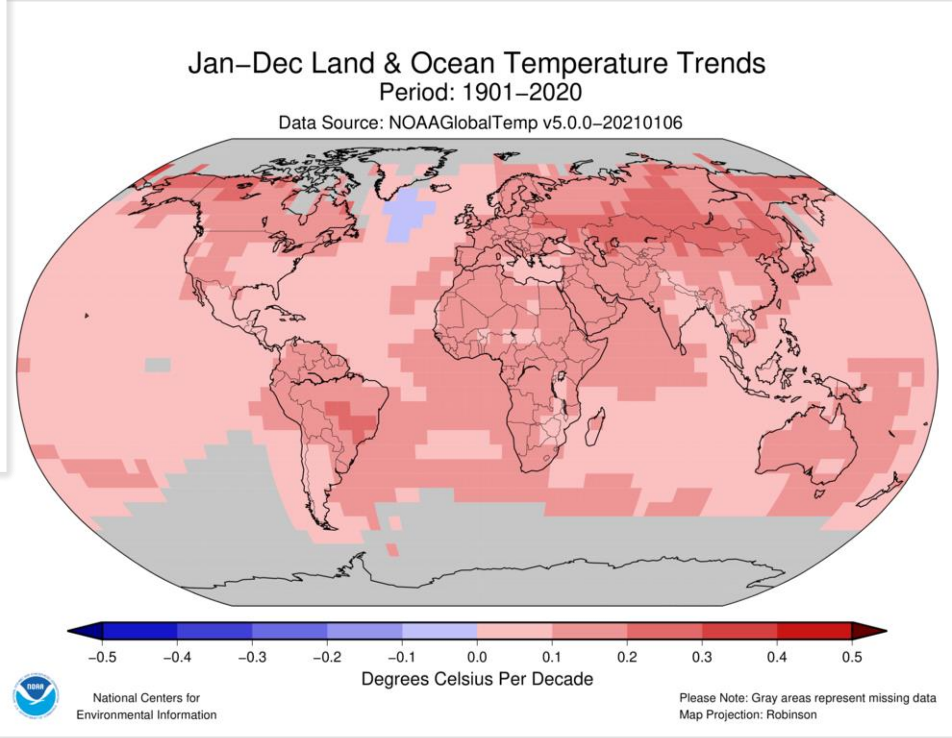
Annual Trends through 2020

Increase in *rate* of warming over the past three decades in most areas



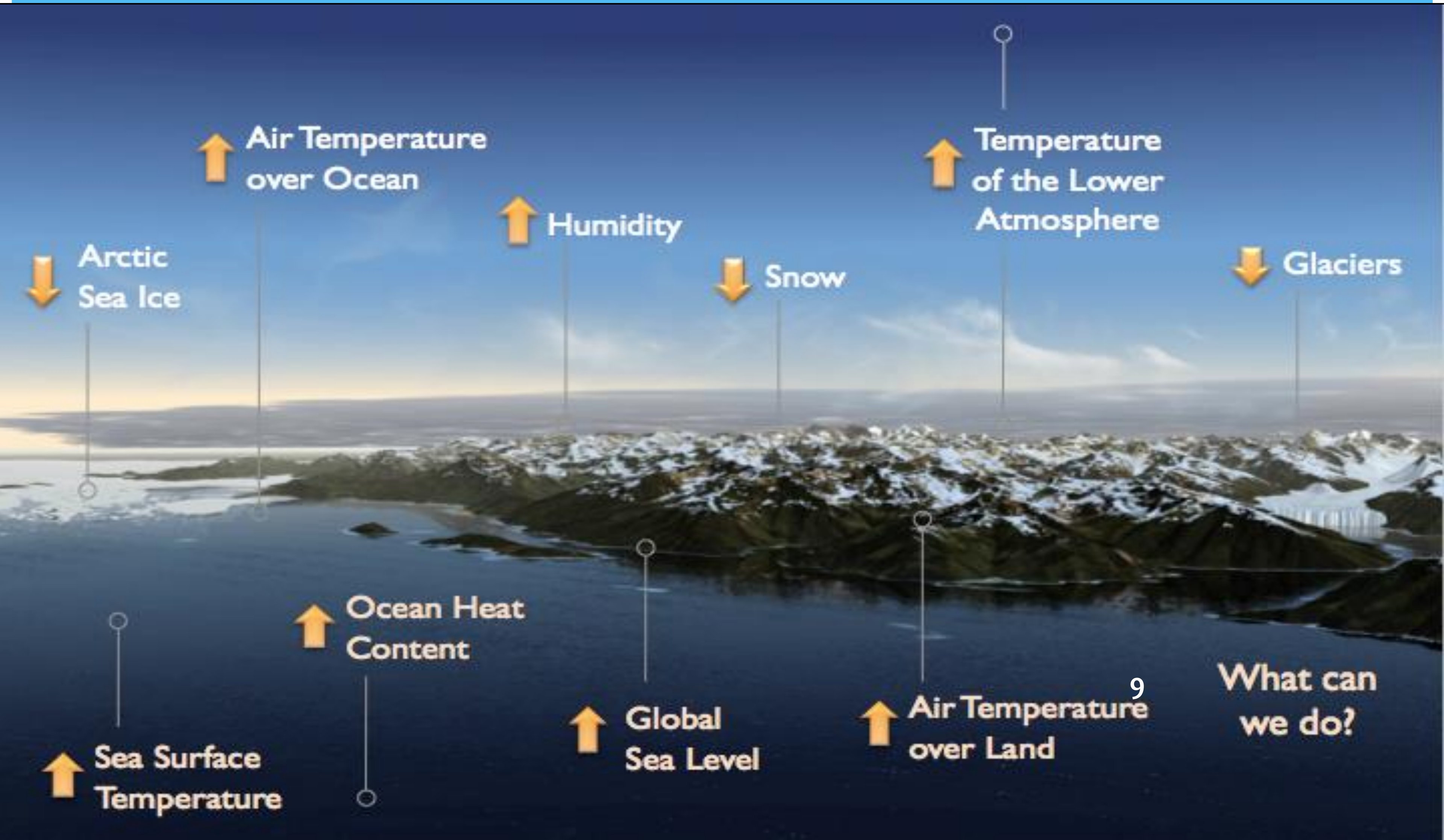
Last 30 years

Last 120 years

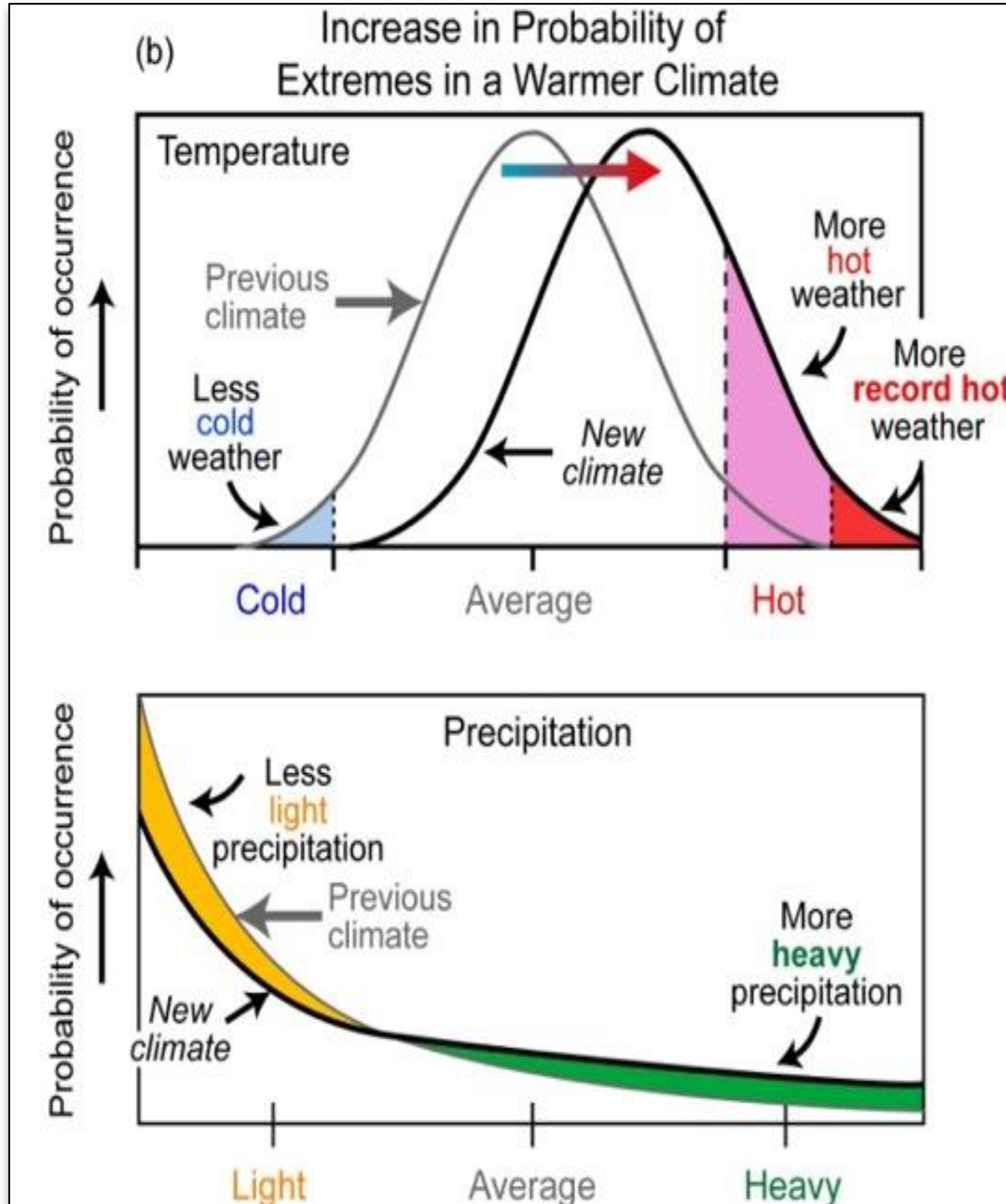


https://www.ncdc.noaa.gov/sotc/

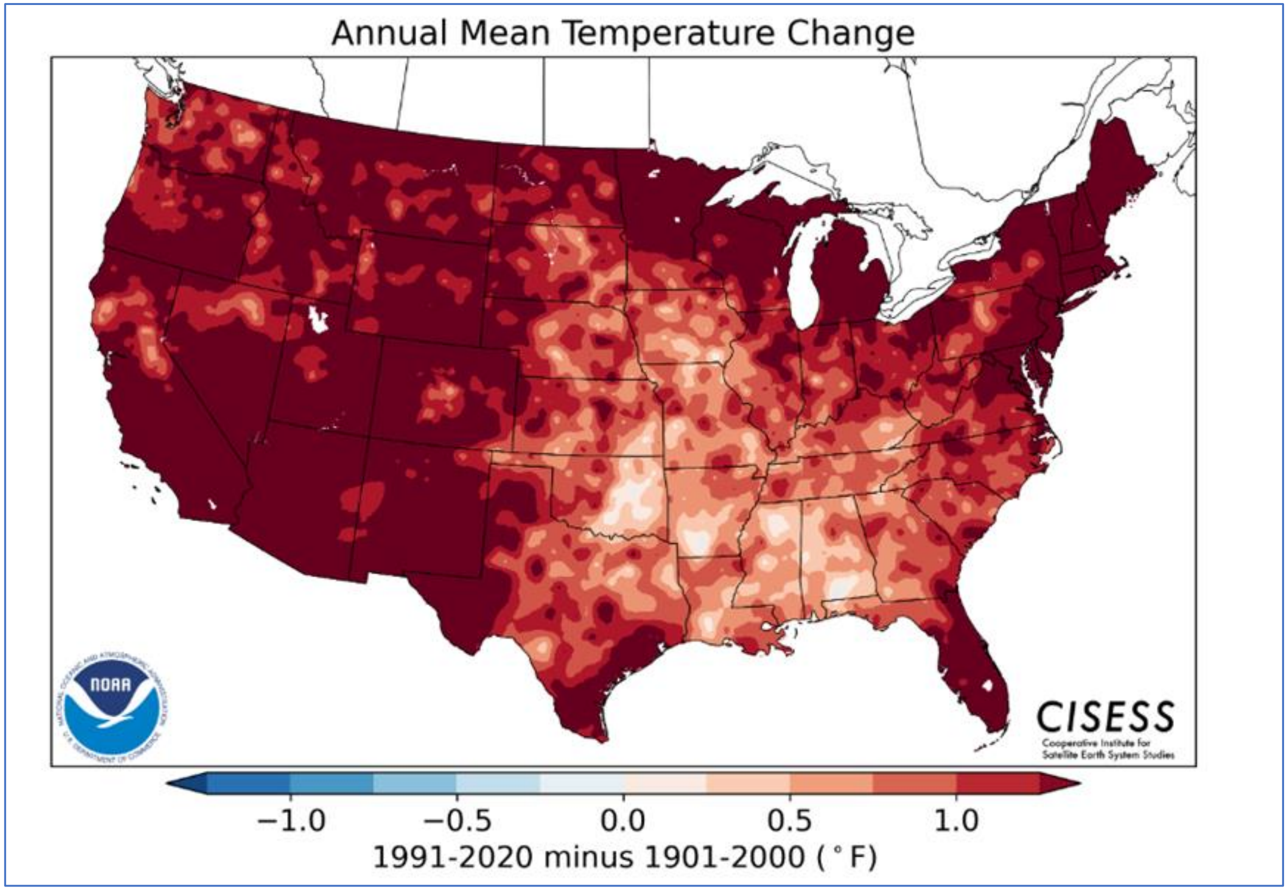
Changing Climate Conditions Contribute to Extremes



Climate scientists predicted an increase in the probability of extreme events occurring due to global warming…

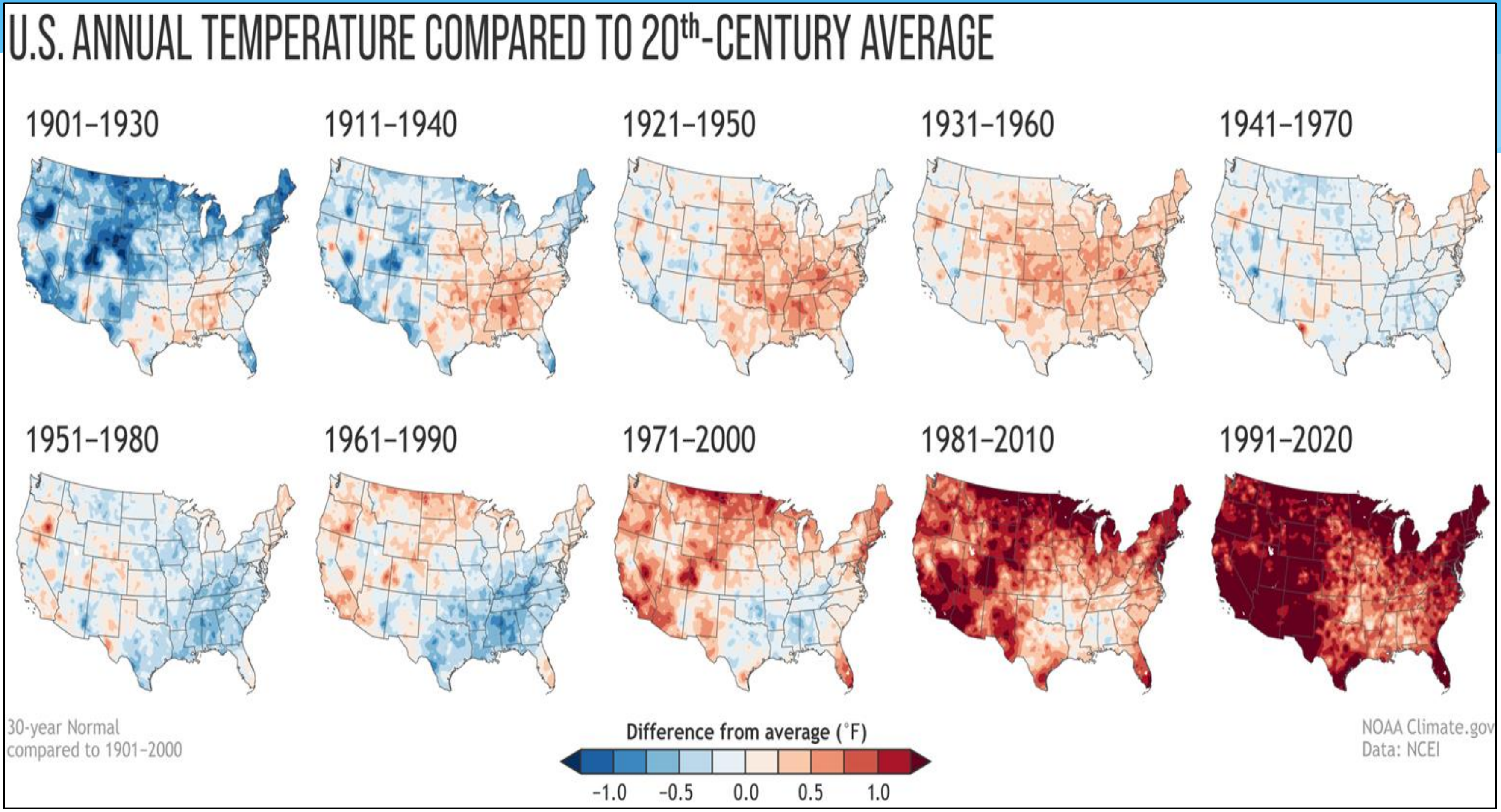


Comparing 1991-2020 to 1901-2000: U.S.



- Climate change is clearly seen in comparing the new normals to the Twentieth Century averages

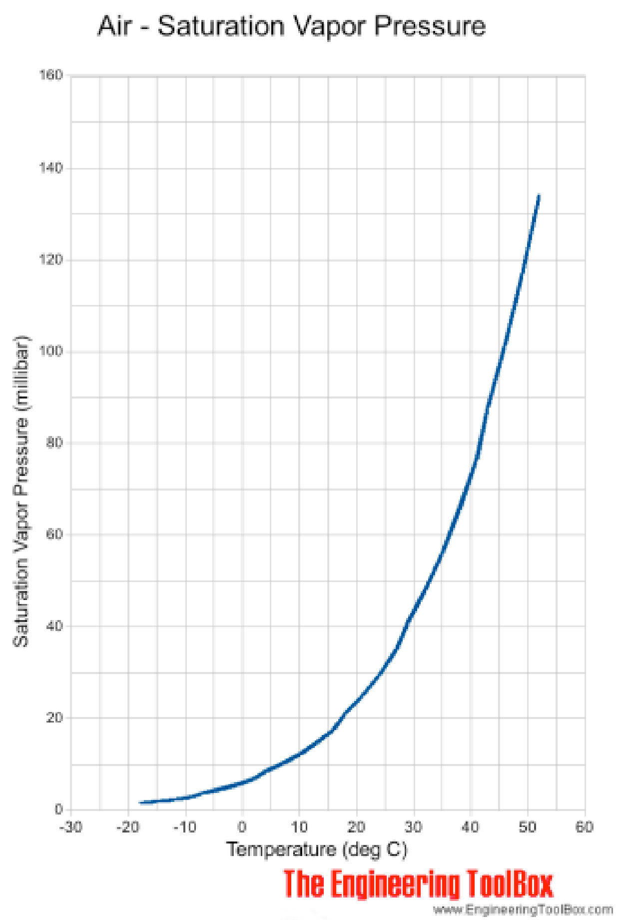
Annual Temperature Normals since 1901 Compared to the 20th Century Average



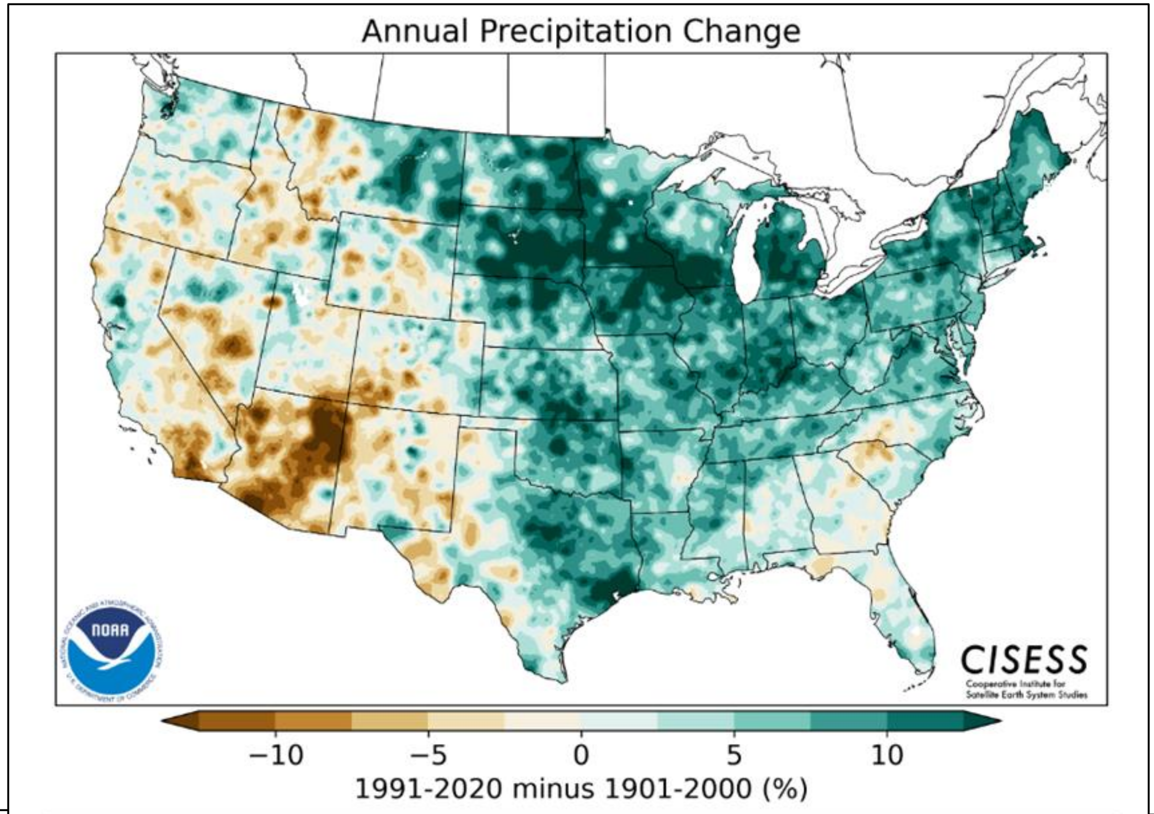
https://www.climate.gov/news-features/understanding-climate/climate-change-and-1991-2020-us-climate-normals

Warm Air Holds More Water Vapor: A lot more

- Saturation vapor pressure is the total amount of pressure exerted if the air were saturated (relative humidity 100%)
  - Nearly doubles for every 10 deg C increase in temperature
  - Warm tropical air can hold 4-10 times as much vapor as cold, dry air
  - Consequently more latent heat release in storms, more precipitation



Recent 30 years (1991-2020) compared to the past (1901-2000)



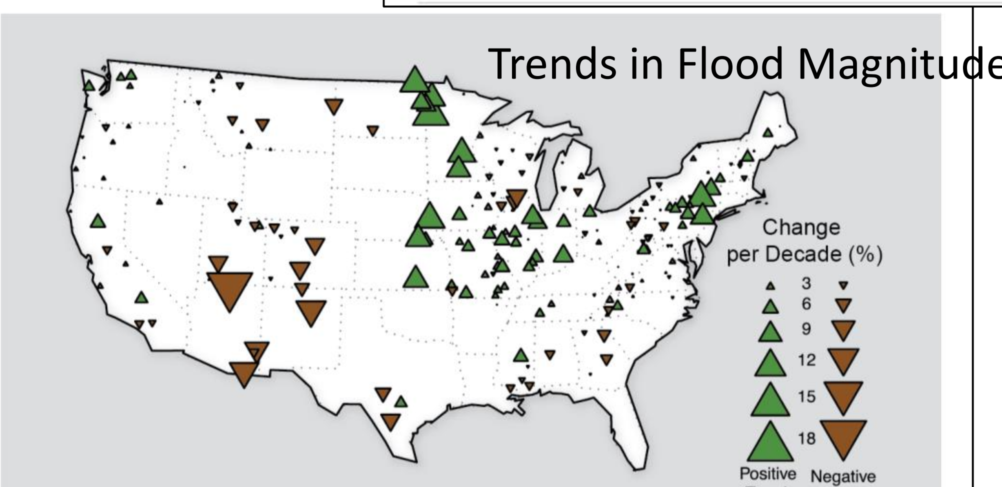
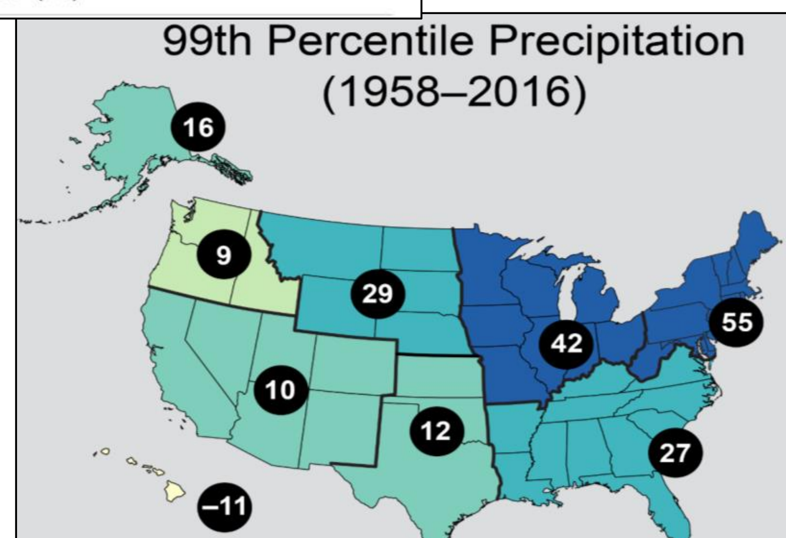
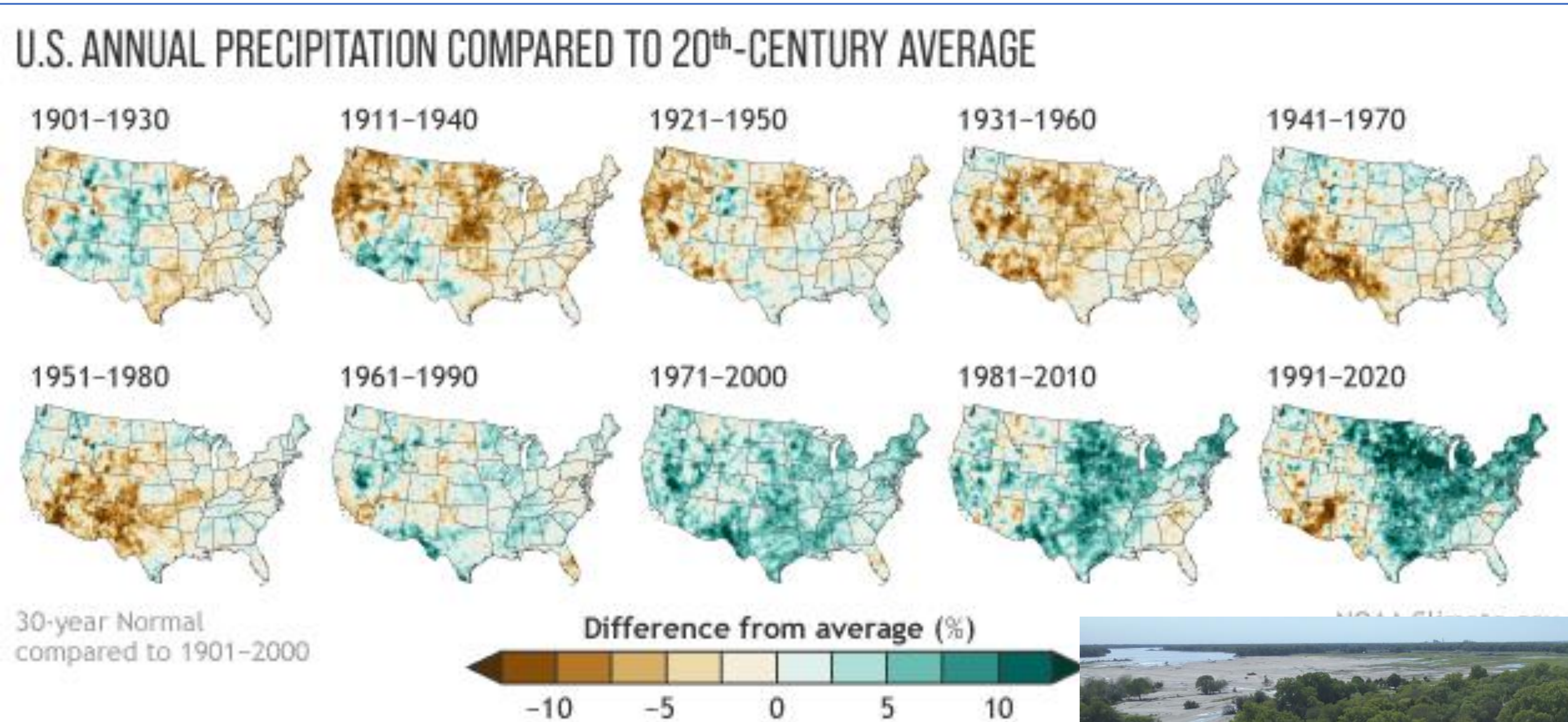


Figure source: Peterson et al. 2013



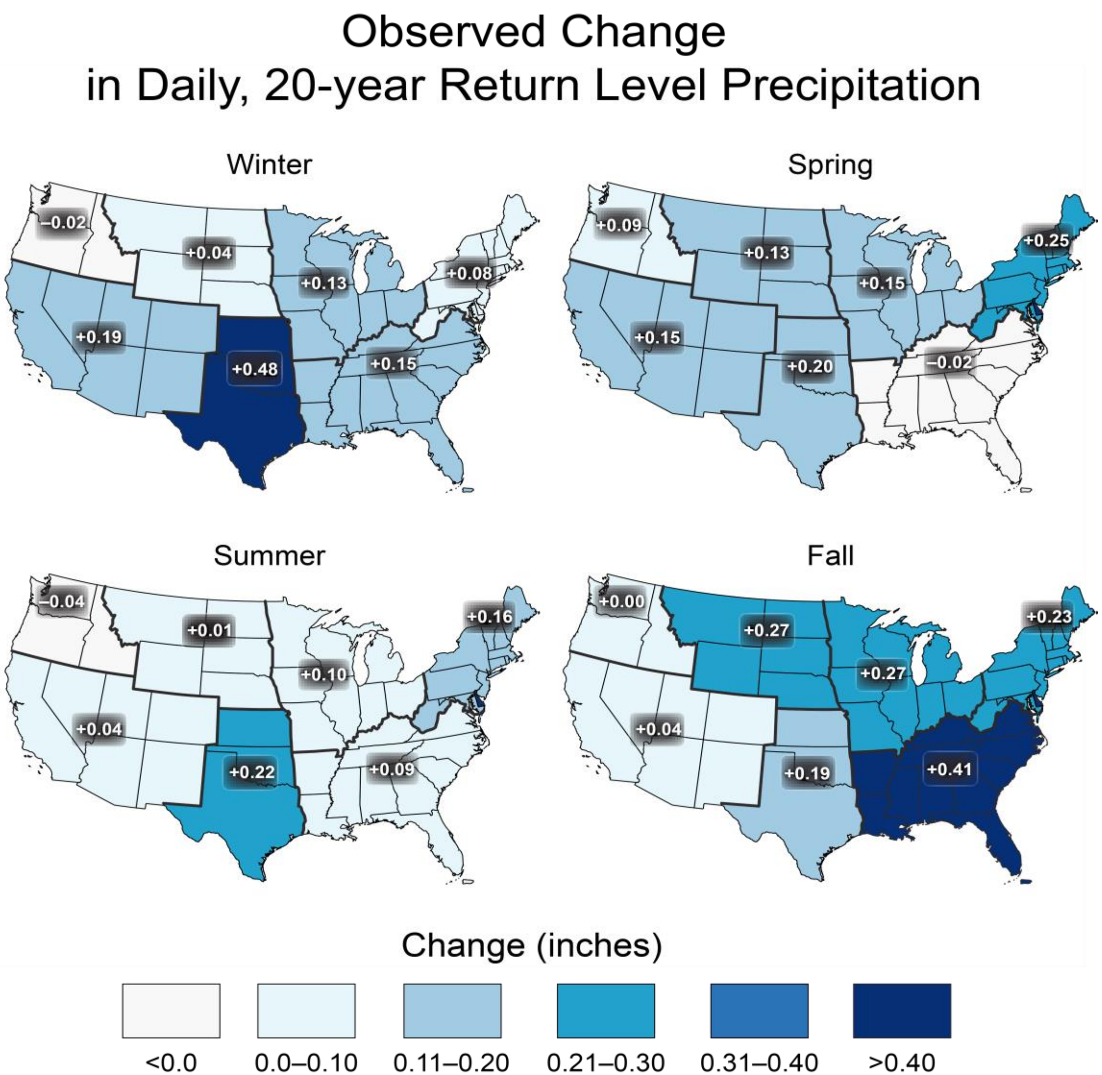
Precipitation Changes Over the Decades (1901 -2020)



U.S. Global Change Research Program

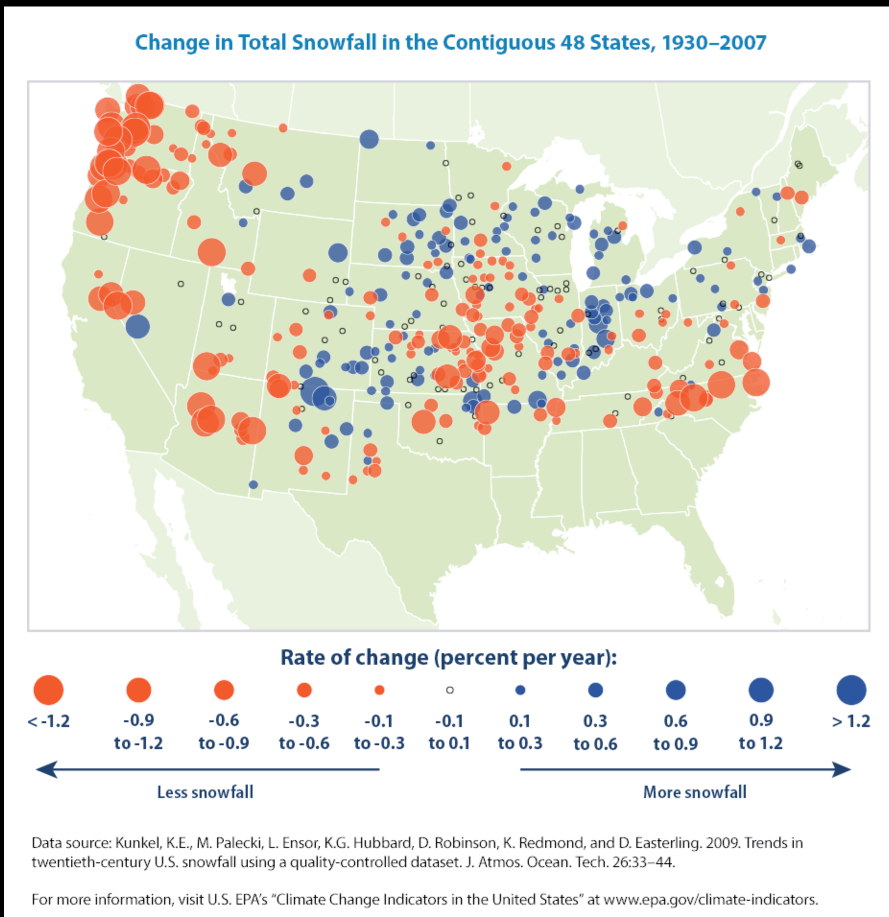
Fourth National Climate Assessment, Vol II — Impacts, R
States

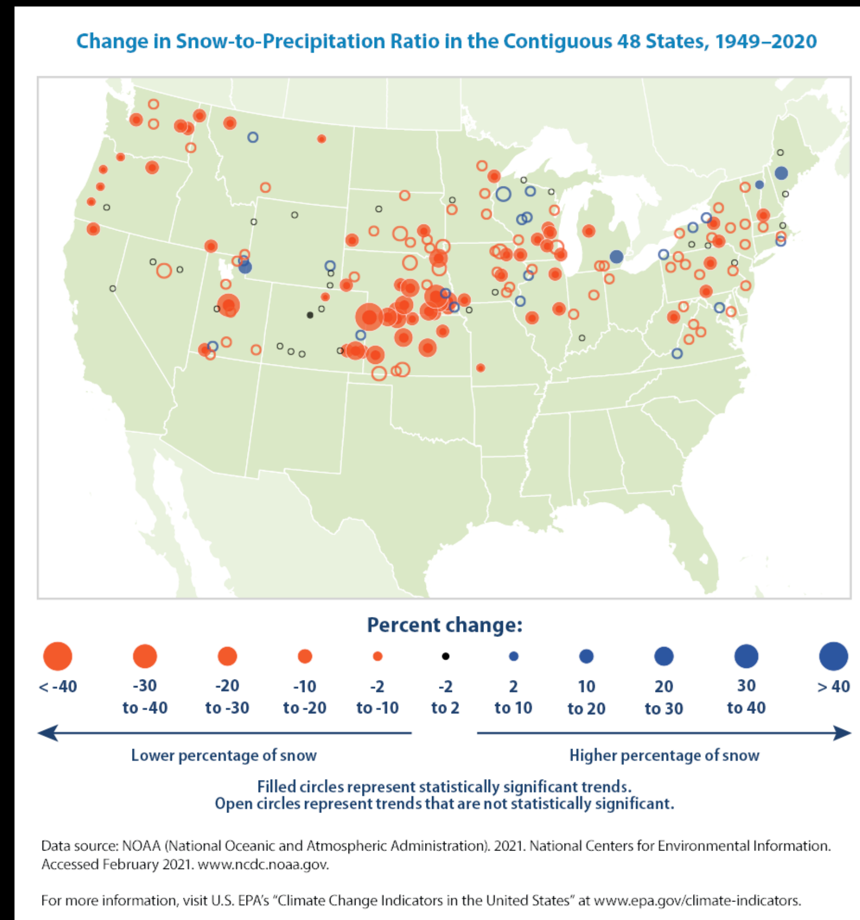
Heavy Rainfall



- Daily 20-year Return means amount of rainfall expected to occur, on average, once every 20 years
- Amounts have increased more than 0.4 inch in places (slight decrease in some places)
- Varies geographically by season

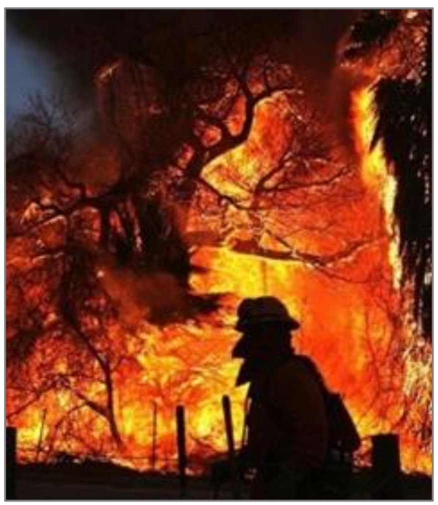
Snowfall: Increases in total snowfall amounts in the Northern Plains but increases in the proportion of precipitation falling as rain





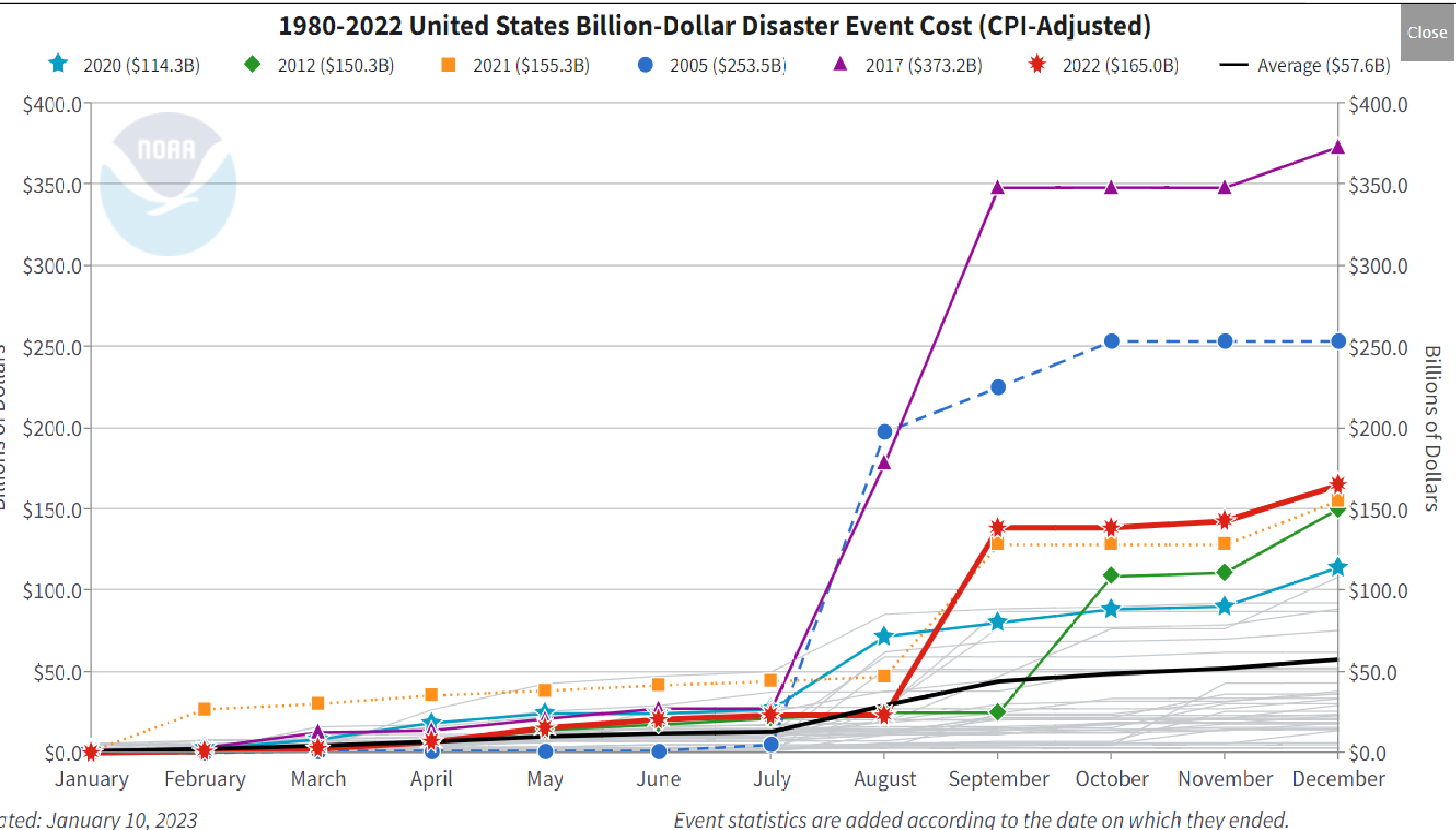
Extremes…

More frequent & more severe extreme events.
Communities & businesses are feeling the impacts.



The total cost of these 341 events exceeds $2.475 trillion

U.S. Disaster Trends

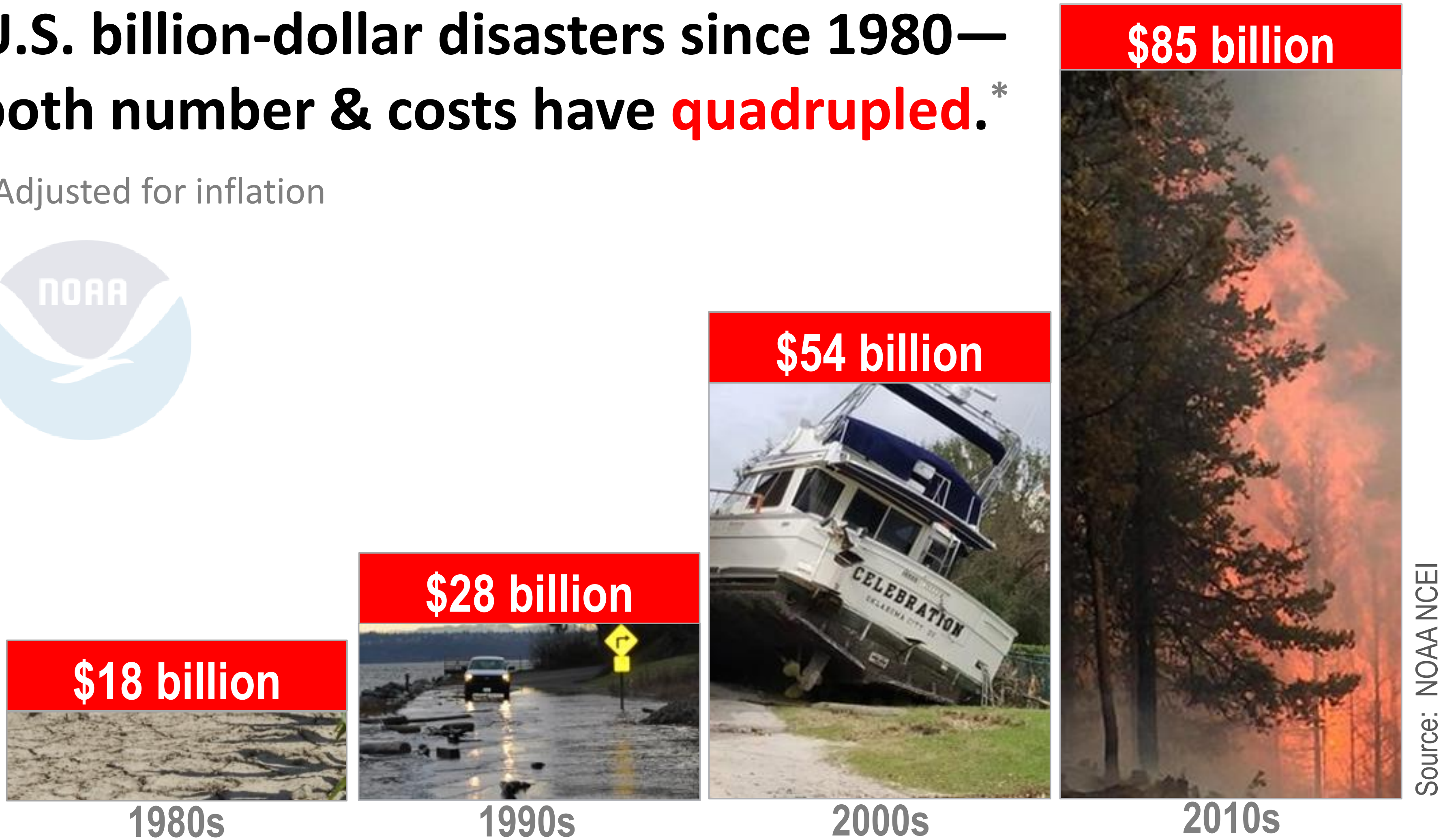


ated: January 10, 2023

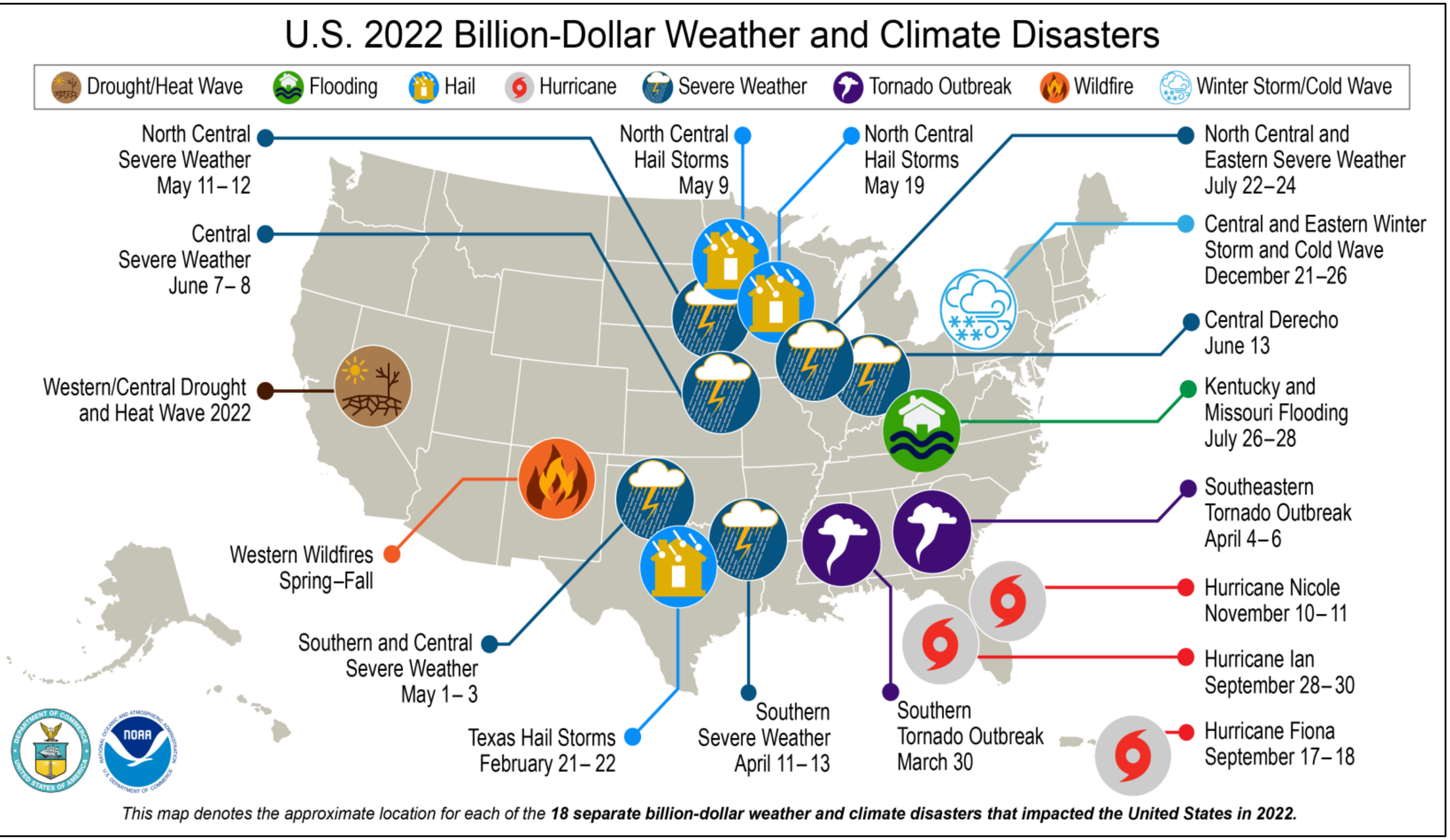
Event statistics are added according to the date on which they ended.

U.S. billion-dollar disasters since 1980—both number & costs have quadrupled.*

*Adjusted for inflation



2022 Billion $ Disasters



2022

474 deaths

18 events

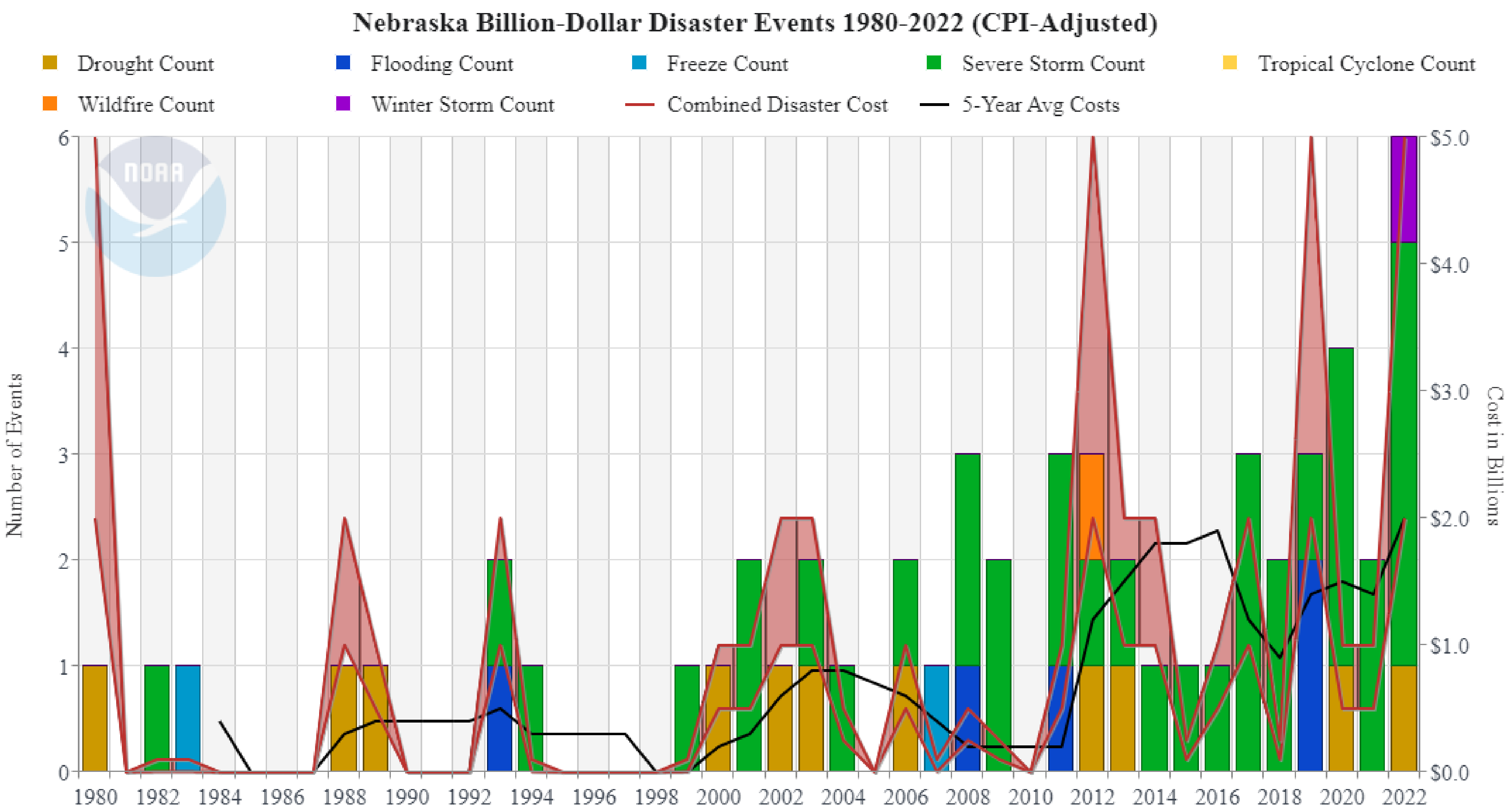
$165 billion

1+ trillion last 7 years

https://www.ncei.noaa.gov/access/billions/

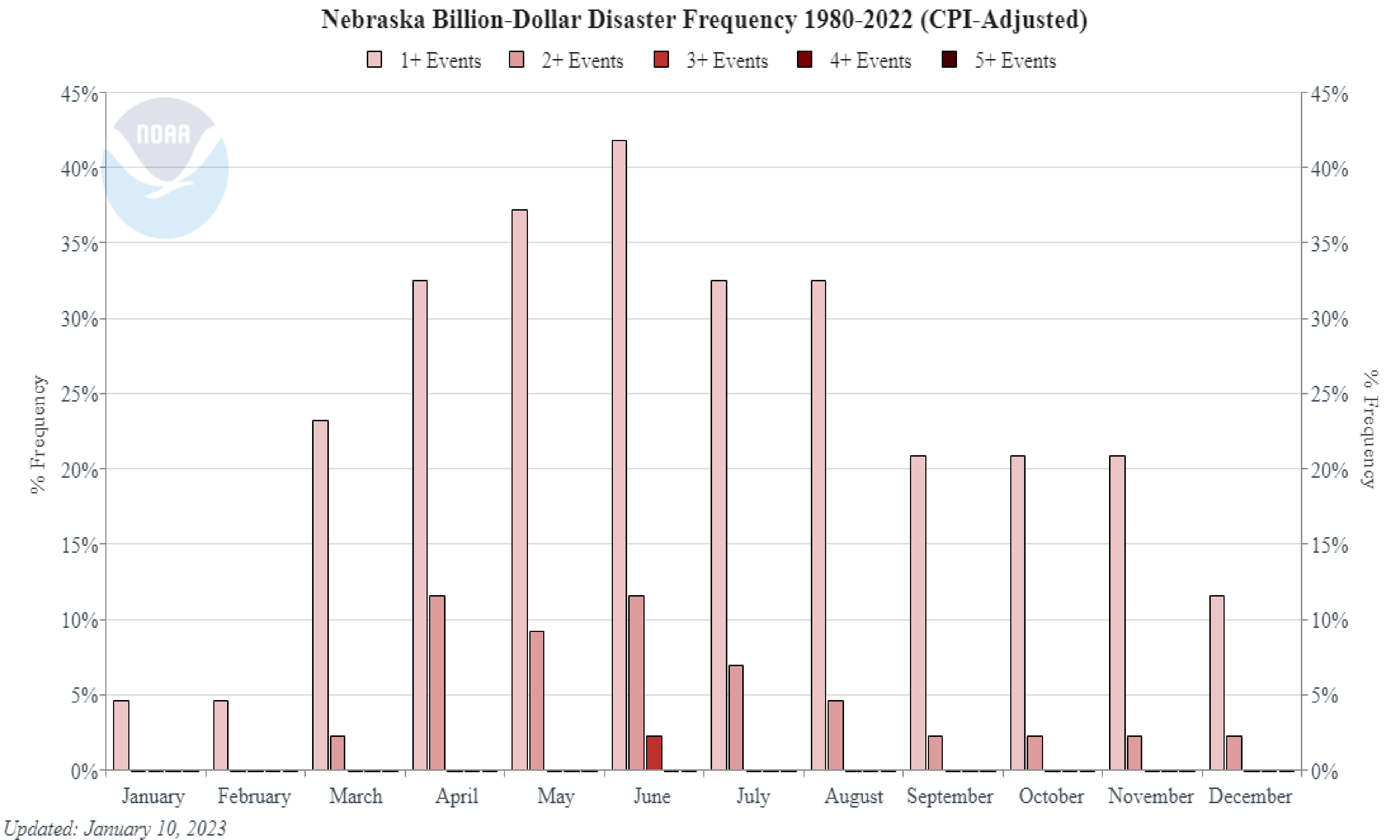
NE Disaster Trends

https://www.ncei.noaa.gov/access/billions/time-series/NE



Updated: January 10, 2023

Nebraska Disasters by Month



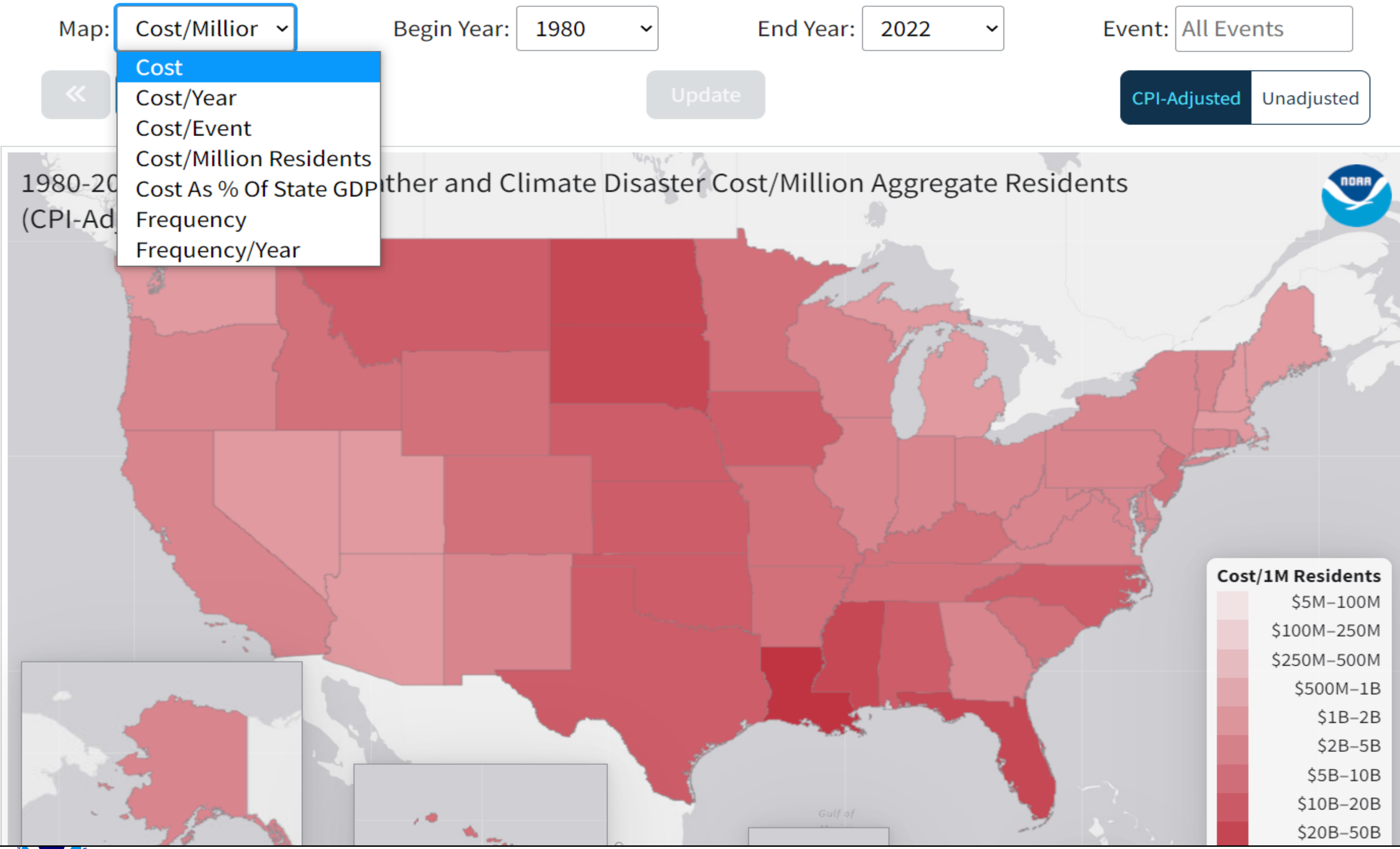
Total Impacts By Disaster Type (NE)

https://www.ncei.noaa.gov/access/billions/summary-stats

Billion-dollar events to affect Nebraska from 1980 to 2022 (CPI-Adjusted)

Disaster Type	Events	Events/Year	Percent Frequency	Total Costs	Percent of Total Costs
Drought	11	0.3	20.0%	\$10.0B-\$20.0B	46.4%
Flooding	5	0.1	9.1%	\$2.0B-\$5.0B	15.0%
Freeze	2	0.0	3.6%	\$5M-\$100M	0.2%
Severe Storm	35	0.8	63.6%	\$10.0B-\$20.0B	38.2%
Tropical Cyclone	--	--	--	--	--
Wildfire	1	0.0	1.8%	\$5M-\$100M	0.2%
Winter Storm	1	0.0	1.8%	\$0M-\$0M‡	0.0%‡
All Disasters	**55**	**1.3**	**100.0%**	**\$20.0B-\$50.0B‡**	**100.0%‡**

Disaster Cost and Frequency



https://www.ncei.noaa.gov/access/billions/mapping

Interactive U.S. county hazard risk maps

- NCEI worked with & expanded upon FEMA's NRI (National Risk Index) team to enhance the NOAA Billion-dollar disaster website producing **127 new, interactive U.S. county hazard risk maps** for any combination of county-level hazard risk for:

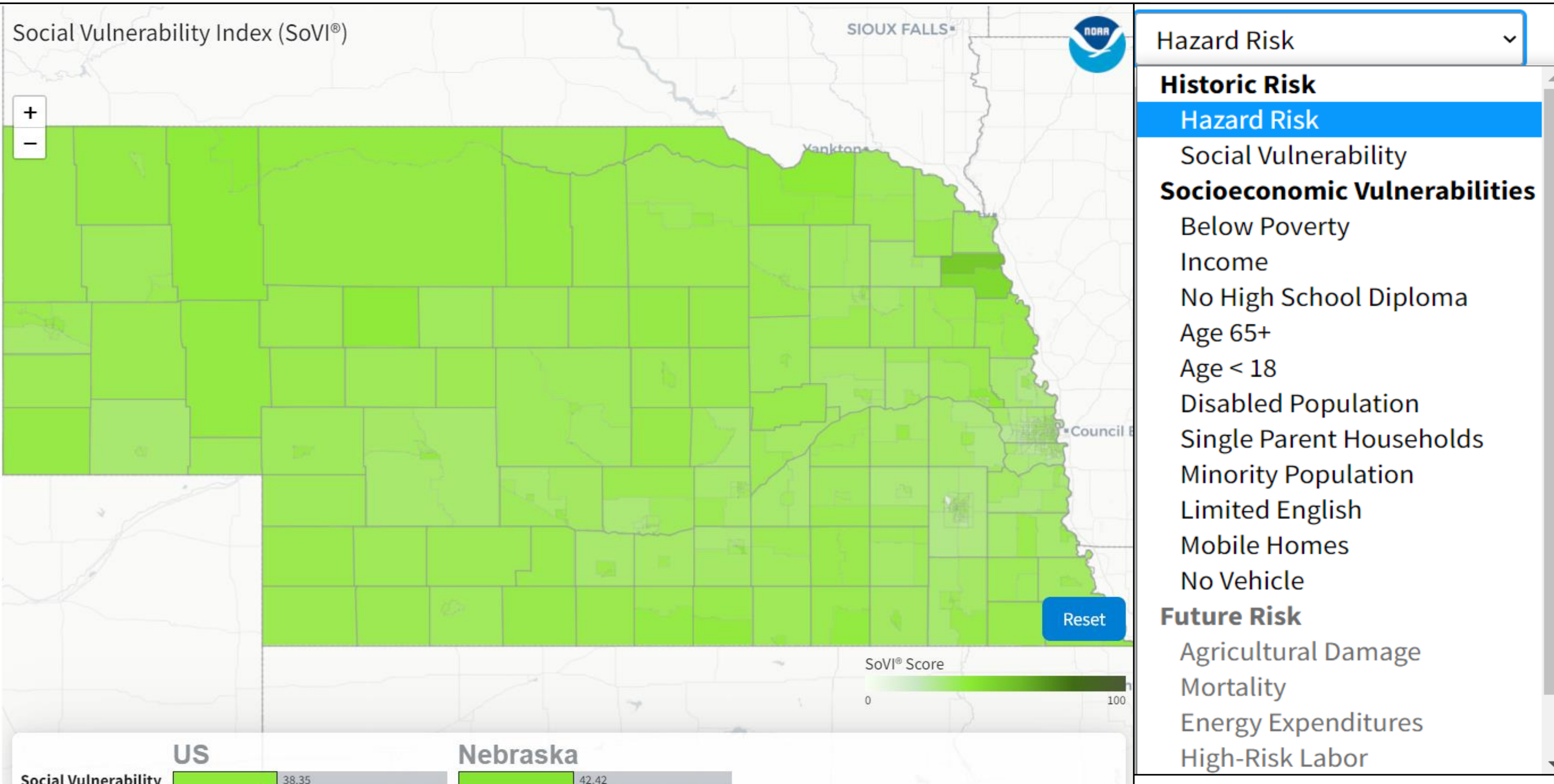
  hurricanes, severe storms (tornado, hail, damaging winds), inland/urban flooding, drought/heat wave, wildfire, winter storms and freeze/cold wave events.

- Importantly, these maps offer more granular information in relation to **exposure, vulnerability and resilience** to weather & climate hazards, at a county scale.

- These new hazard combination maps are useful as we see more focus on **cascading hazard impacts**

  For example: drought-enhanced wildfires produce mountain-side burn scars, which often enhance debris flows from flooding. This is a compound hazard with cascading impacts that we see in California.

NE Risk and Vulnerability



https://www.ncei.noaa.gov/access/billions/mapping

Risk and Vulnerability by County/Tract (Harlan County)

Socioeconomic Vulnerabilities	Census Tract 9642	Harlan County	Nebraska	U.S.
Below Poverty (% of Population)	11.20%	11.20%	--	--
Income (Per Capita Income)	$27,421.00	$27,421.00	$--	$--
No High School Diploma (% of Population)	9.90%	9.90%	--	--
Age 65+ (% of Population)	25.00%	25.00%	--	--
Age < 18 (% of Population)	22.50%	22.50%	--	--
Disabled Population (% of Population)	16.30%	16.30%	--	--
Single Parent Households (% of Population)	3.90%	3.90%	--	--
Minority Population (% of Population)	6.10%	6.10%	--	--
Limited English (% of Population)	0.40%	0.40%	--	--
Mobile Homes (% of Homes)	22.90%	22.90%	--	--
No Vehicle (% of Households)	1.80%	1.80%	--	--
Energy Expenditures (% Change)	--	10.24%	9.01%	9.24%
High-Risk Labor (% Change)	--	-1.50%	-1.58%	-1.51%
Coastal Storm Damage (% County GDP)	--	--	--	0.29%
Total Damage (% County GDP)	--	2.54%	2.06%	4.57%

https://www.ncei.noaa.gov/access/billions/mapping

Impacts

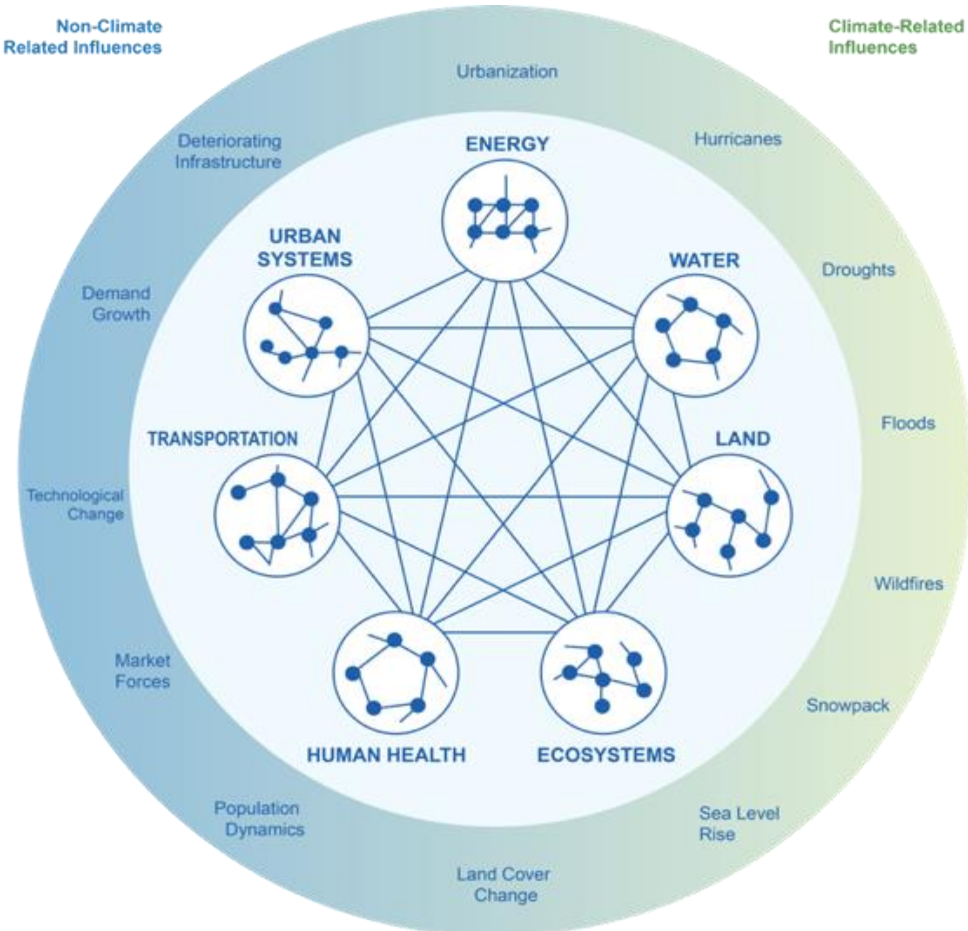
Current and Potential Impacts

- **Health (smoke, heat, allergies, invasive diseases)**
- **Water (quantity, quality)**
- **Drought/Flood (flash, urban/rural issues, energy production)**
- **Cascading issues (e.g. migration, supply chains)**
- **Infrastructure (transportation, utilities etc..)**
- **Rural (Ag. implications, heat health)**
- **Ecosystems (loss of habitat, restorative ability, balance)**
- **Equity: Vulnerable populations especially vulnerable to small "disasters" or series of events**
  - **Place based vulnerabilities (flood plain, etc…)**

Record-Setting Wildfire Season

Over 10 million acres burned, California and Colorado were scorched

Extreme events tend to cause multi-stressor situations



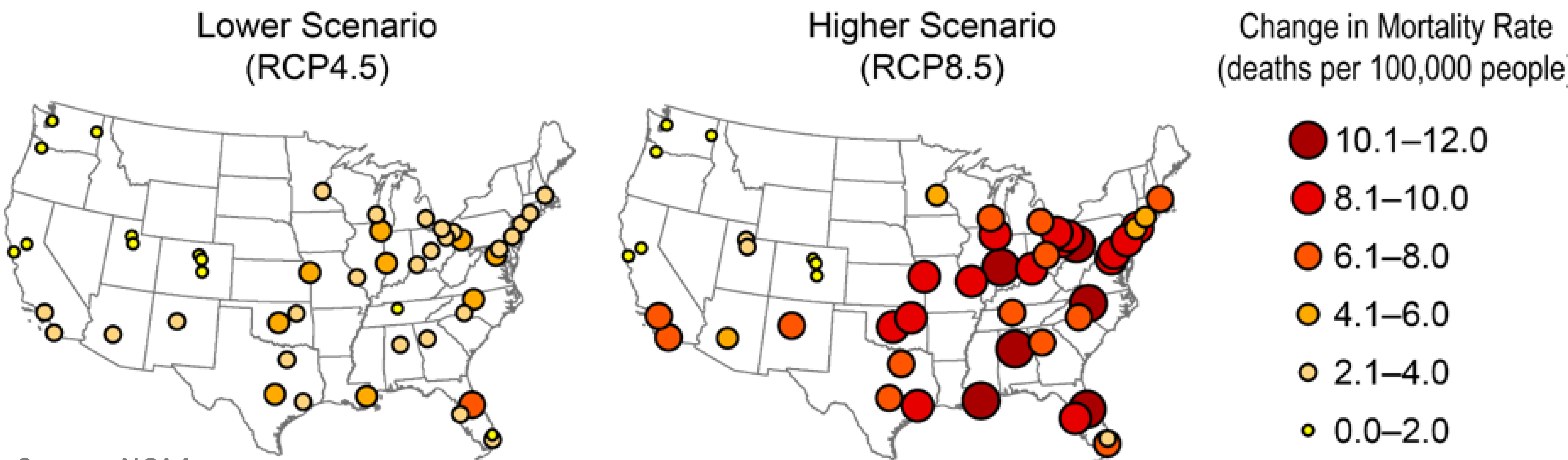
Sectors are interacting & interdependent through physical, social, institutional, environmental, and economic linkages.

These sectors and the interactions among them are affected by a range of climate-related and non-climate influences.

<u>Example</u>

1. Wildfire chars California hillside
2. Atmospheric river dumps heavy rain
3. Rainfall causes a landslide
4. Landslide cuts off roadways
5. Services and economic activity are disrupted

Increases in heat-related deaths are projected To outweigh reductions in cold-related deaths.



Source: NCA4

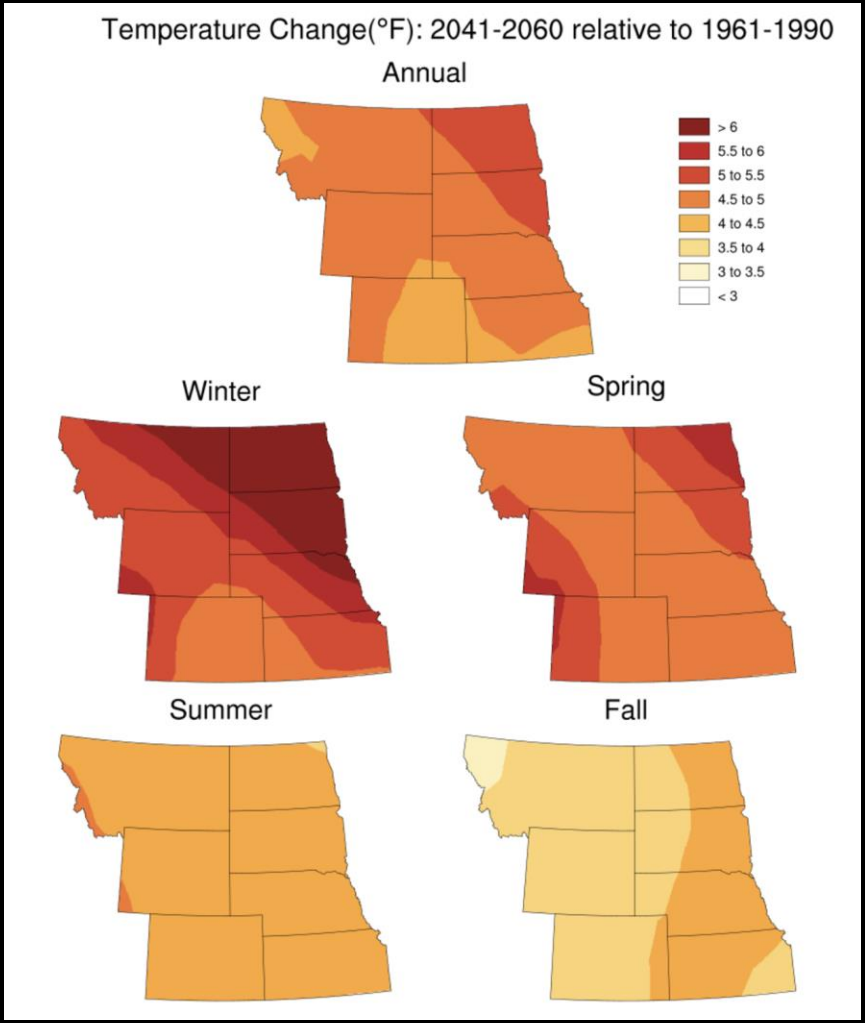
NIHHIS HEAT.gov

National Integrated Heat Health Information System

Temperature Projections

Projected Temperature Change by 2050

- Annual temperatures are expected to increase by 5-6°F
- Winter and Spring to experience the largest increases
- The frequency and intensity of heat spells are projected to increase throughout the 21st century while those for cold spells are projected to decrease
- Risk of frost damage to vegetation may not change substantially



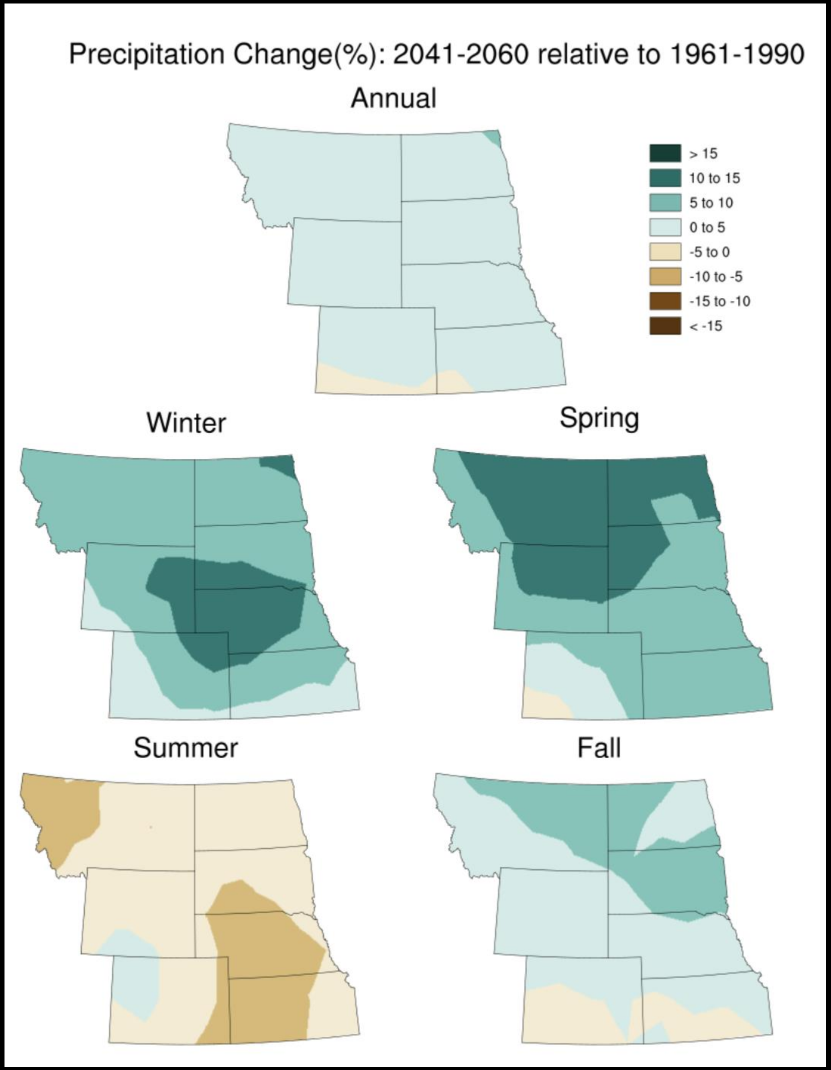
Data: 28 CMIP5 GCMs under a medium emissions scenario (RCP 4.5)

Precipitation Projections

Projected Precipitation Change by 2050

- Annual precipitation is expected to increase with largest increases in spring and winter
- Plausible decreases in summer precipitation by as much as -10%. Less agreement across models for precipitation changes in summer and fall
- High confidence that future storms and precipitation events will be more extreme

Data: 28 CMIP5 GCMs under a medium emissions scenario (RCP 4.5)



Aridification & Drought

Atmospheric Thirst is Increasing!!!

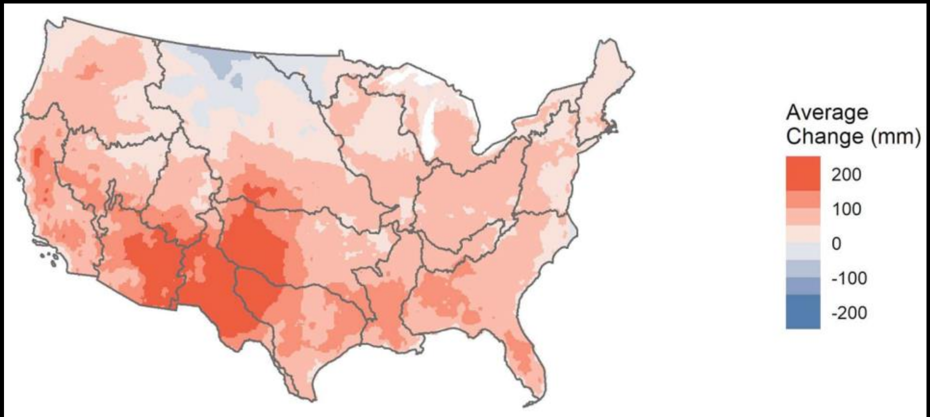
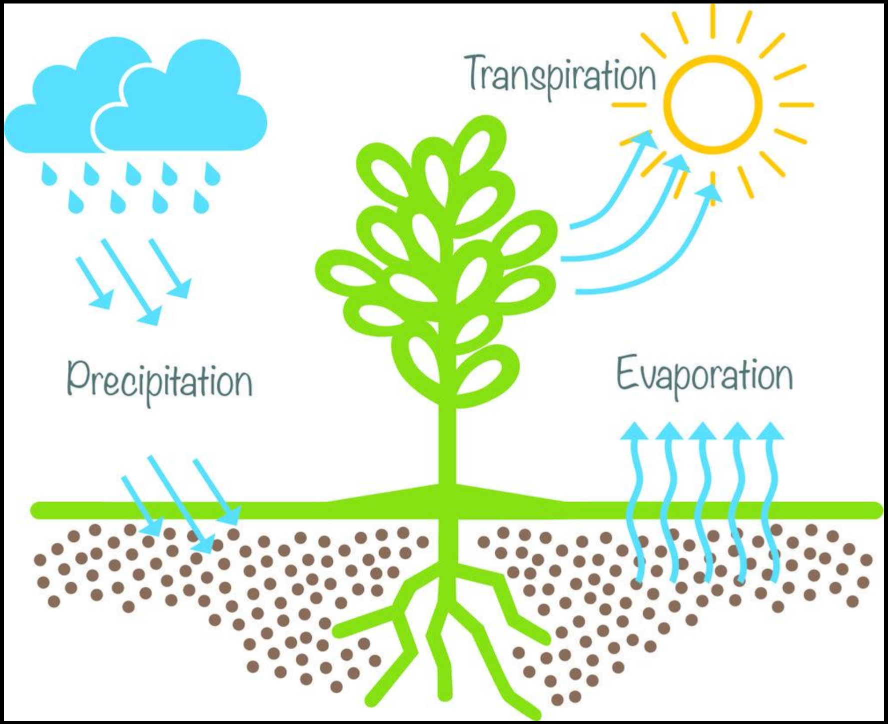
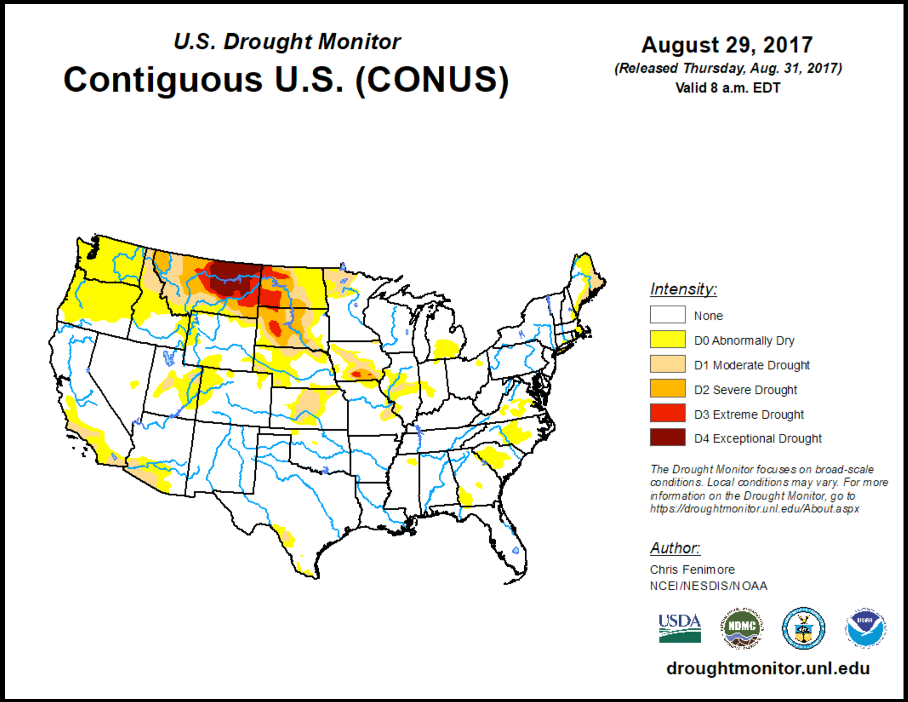


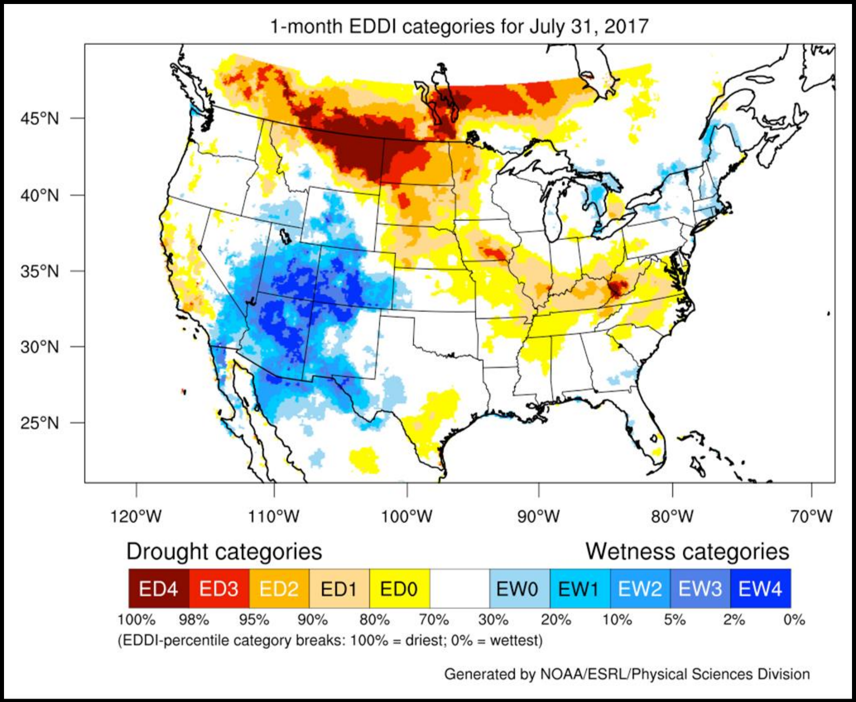
Figure showing changes in atmospheric thirst, measured in terms of reference evapotranspiration (mm), from 1980-2020. The largest changes are centered over the Rio Grande region of the southwestern U.S. Credit: DRI.

Water available on the land is a difference between precipitation and evapotranspiration



Increased Risk of Flash Droughts

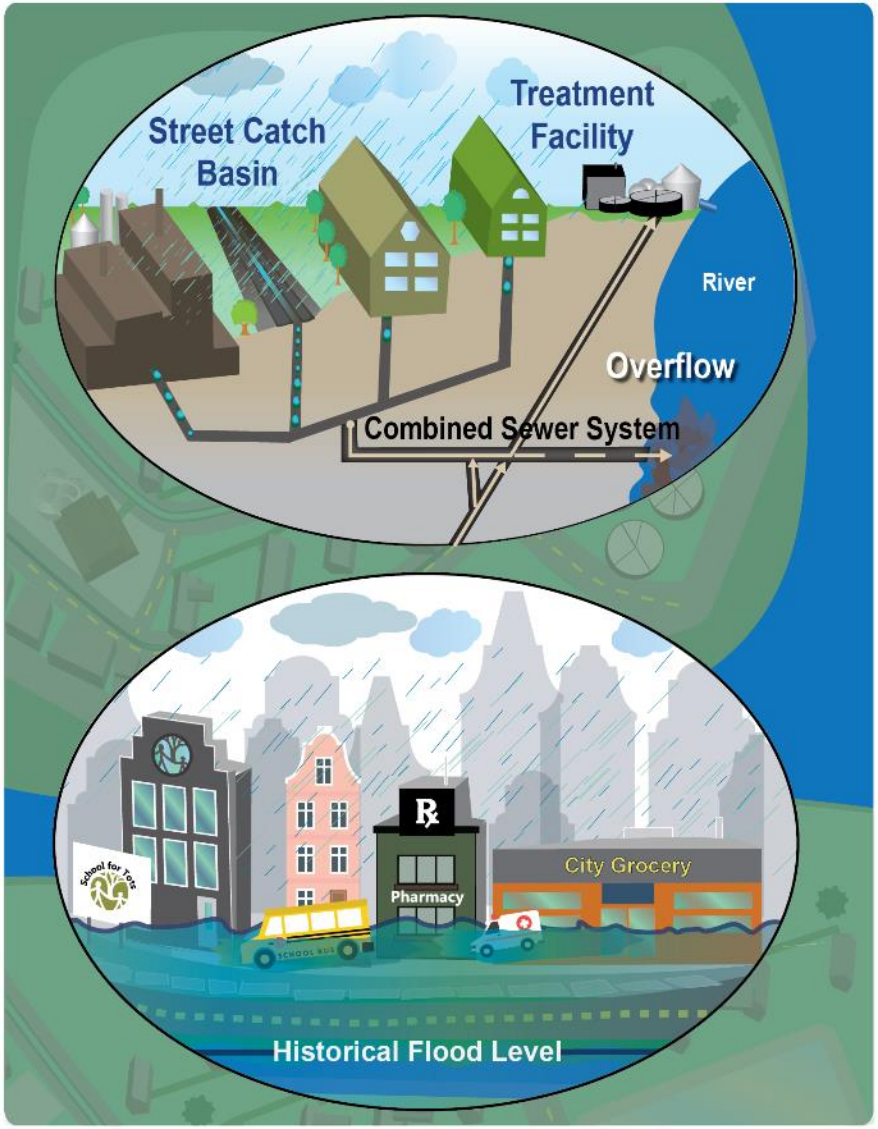




Droughts are found to be developing (drought onset) at a faster rate [globally] in recent decades (Qing and others, 2022)

Fig. 11.6: Cascading Consequences of Heavy Rainfall for Urban Systems

With heavy downpours increasing nationally, urban areas experience costly impacts. (top) In cities with combined sewer systems, storm water runoff flows into pipes containing sewage from homes and industrial wastewater. Intense rainfall can overwhelm the system so untreated wastewater overflows into rivers. Overflows are a water pollution concern and increase risk of exposure to waterborne diseases. (bottom) Intense rainfall can also result in localized flooding. Closed roads and disrupted mass transit prevent residents from going to work or school and first responders from reaching those in need. Home and commercial property owners may need to make costly repairs, and businesses may lose revenue. *Source: EPA.*



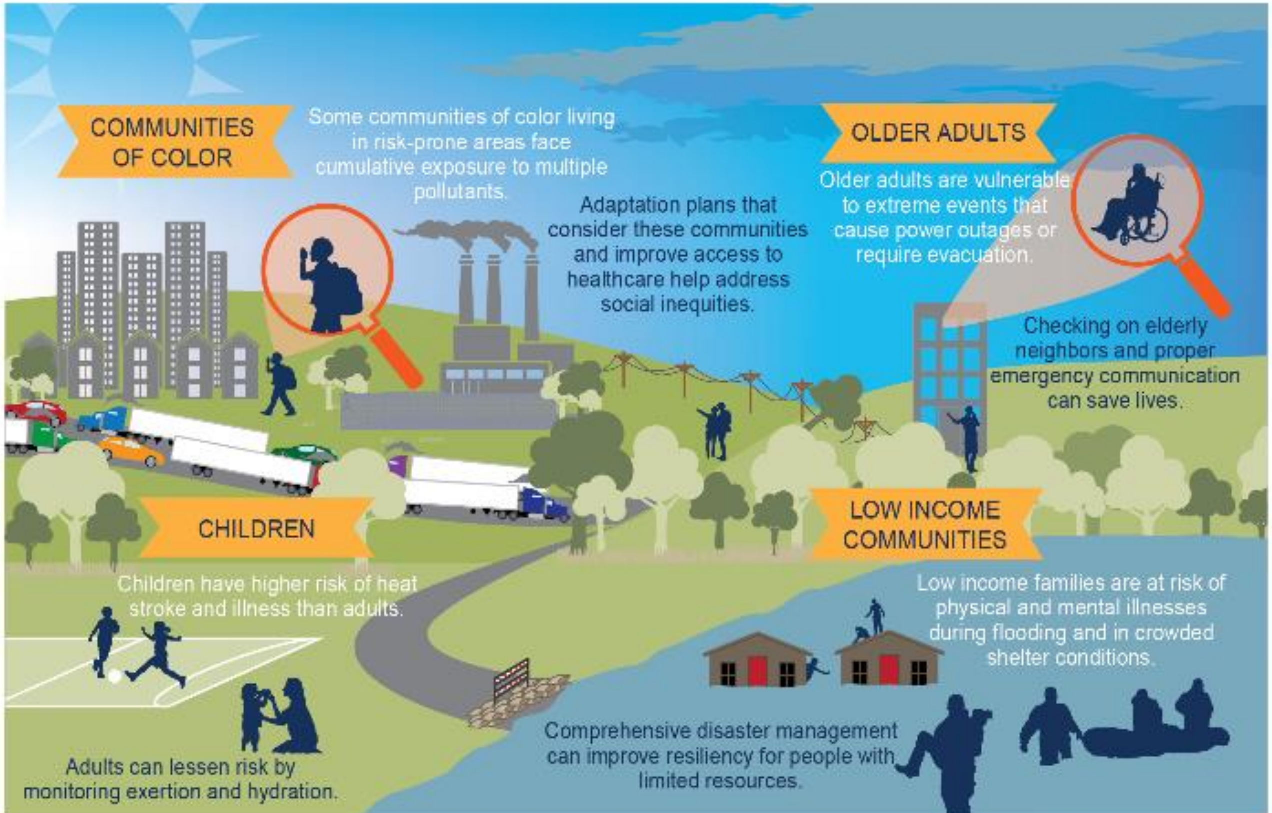


Fig. 14.2: Vulnerable Populations

Examples of populations at higher risk of exposure to adverse climate-related health threats are shown along with adaptation measures that can help address disproportionate impacts. When considering the full range of threats from climate change as well as other environmental exposures, these groups are among the most exposed, most sensitive, and have the least individual and community resources to prepare for and respond to health threats. White text indicates the risks faced by those communities, while dark text indicates actions that can be taken to reduce those risks. *Source: EPA.*

Free, authoritative online sources of information about climate change, impacts, and projections.

For More "Real-time Climate" Information

- Monthly North Central U.S. Climate Summary and Outlook Webinar Series
  - 3rd Thursday of each month

- Quarterly Climate Summary and Outlook
  - Midwest, Great Lakes, Missouri Basin states

- Regional Climate Services email list: doug.kluck@noaa.gov

Climate Mapping For Resilience And Adaptation (CMRA)

CMRA Introduction | Current Hazards | Assessment Tool | Hazard Information | Federal Policies | Open Data

Wildfire

Active fires **86**

Source: National Interagency Fire Center

Drought

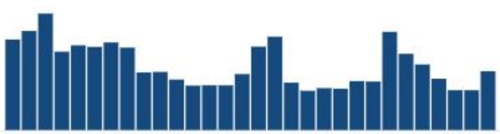
People experiencing drought **74,313,243**

Source: NOAA/NIDIS Drought.gov

Inland Flooding

People under flood alerts **11,287,621**

Last 30 days



Source: NOAA National Weather Service

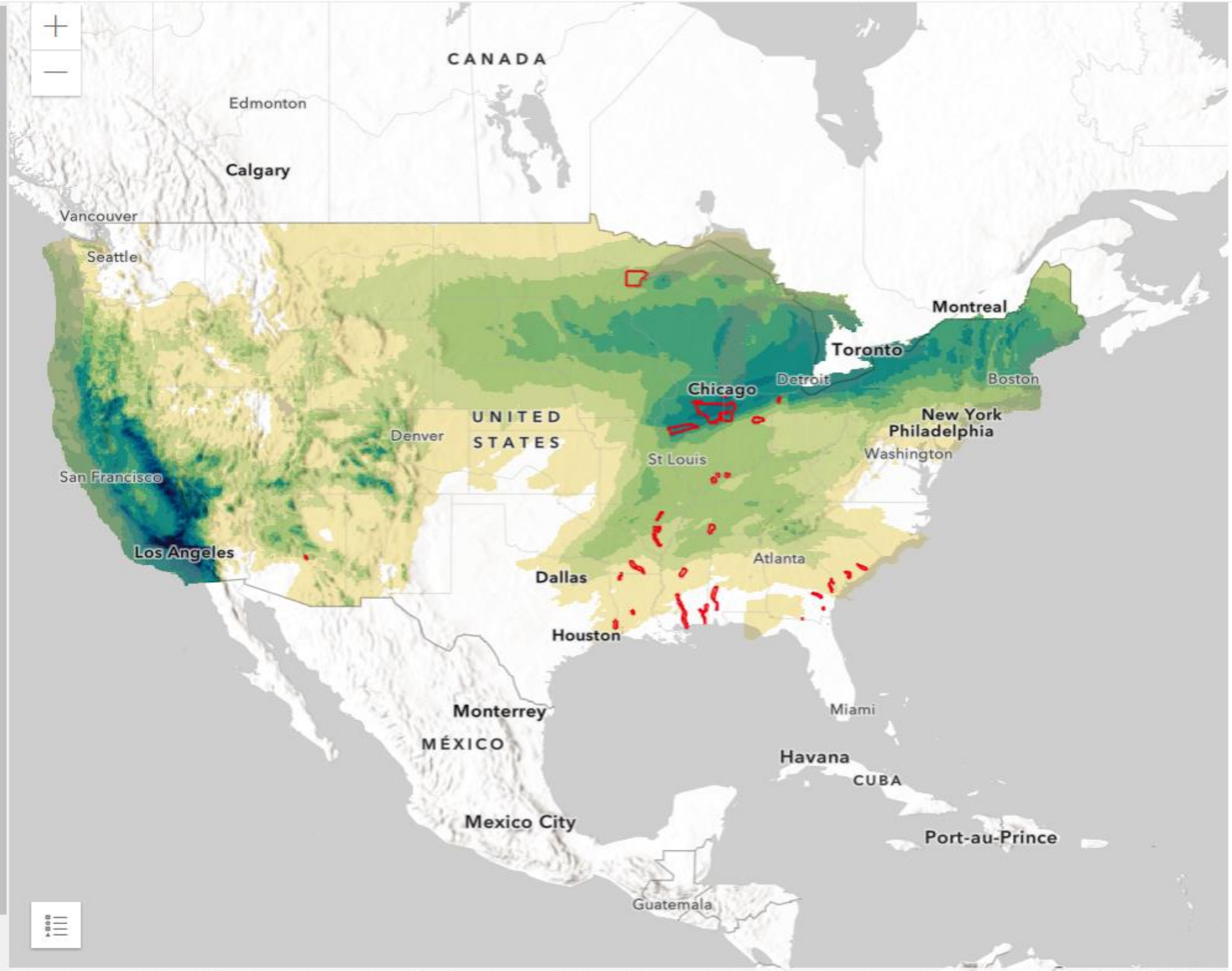
Coastal Flooding

People under flood alerts **0**

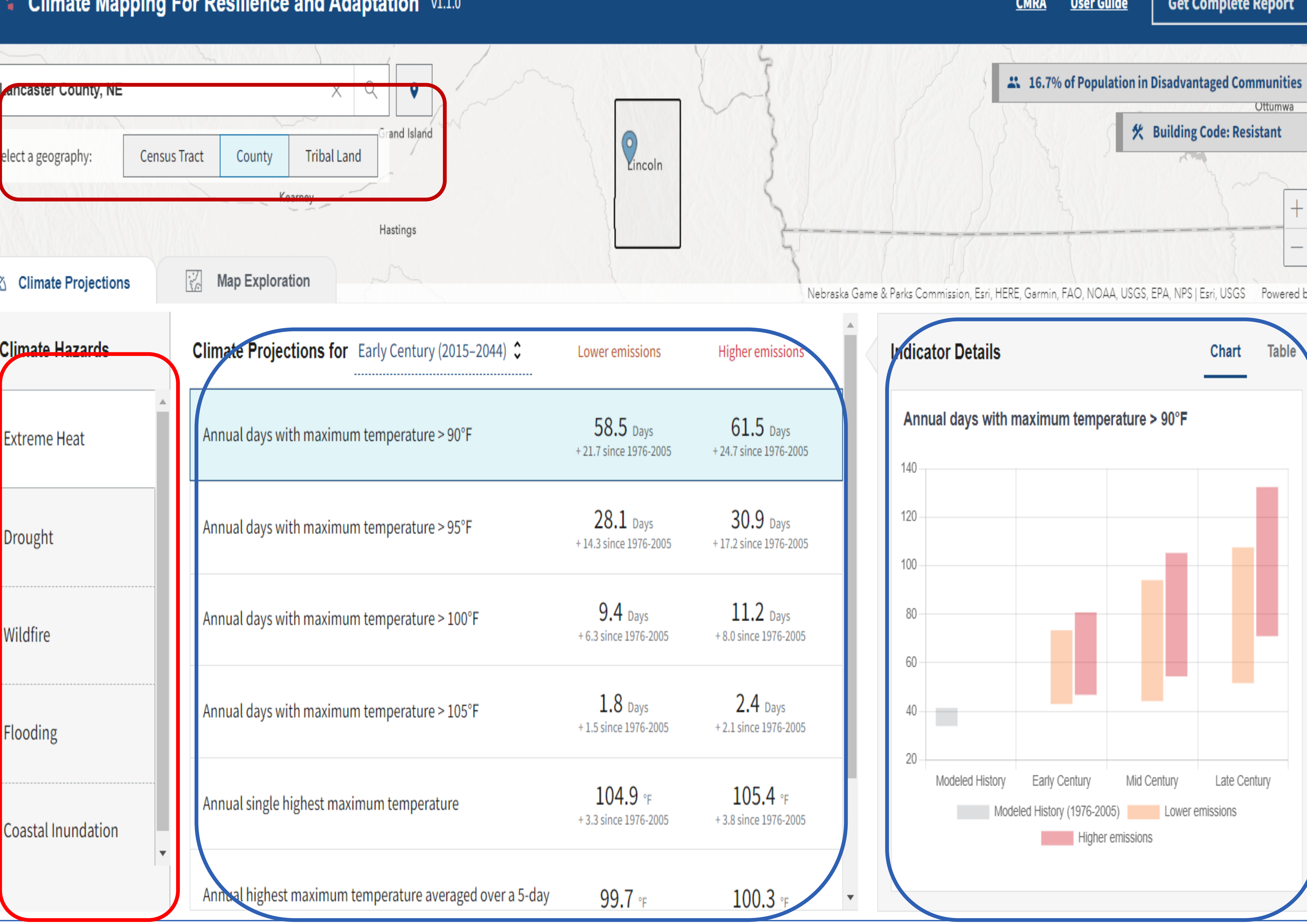
Source: NOAA National Weather Service

Extreme Heat

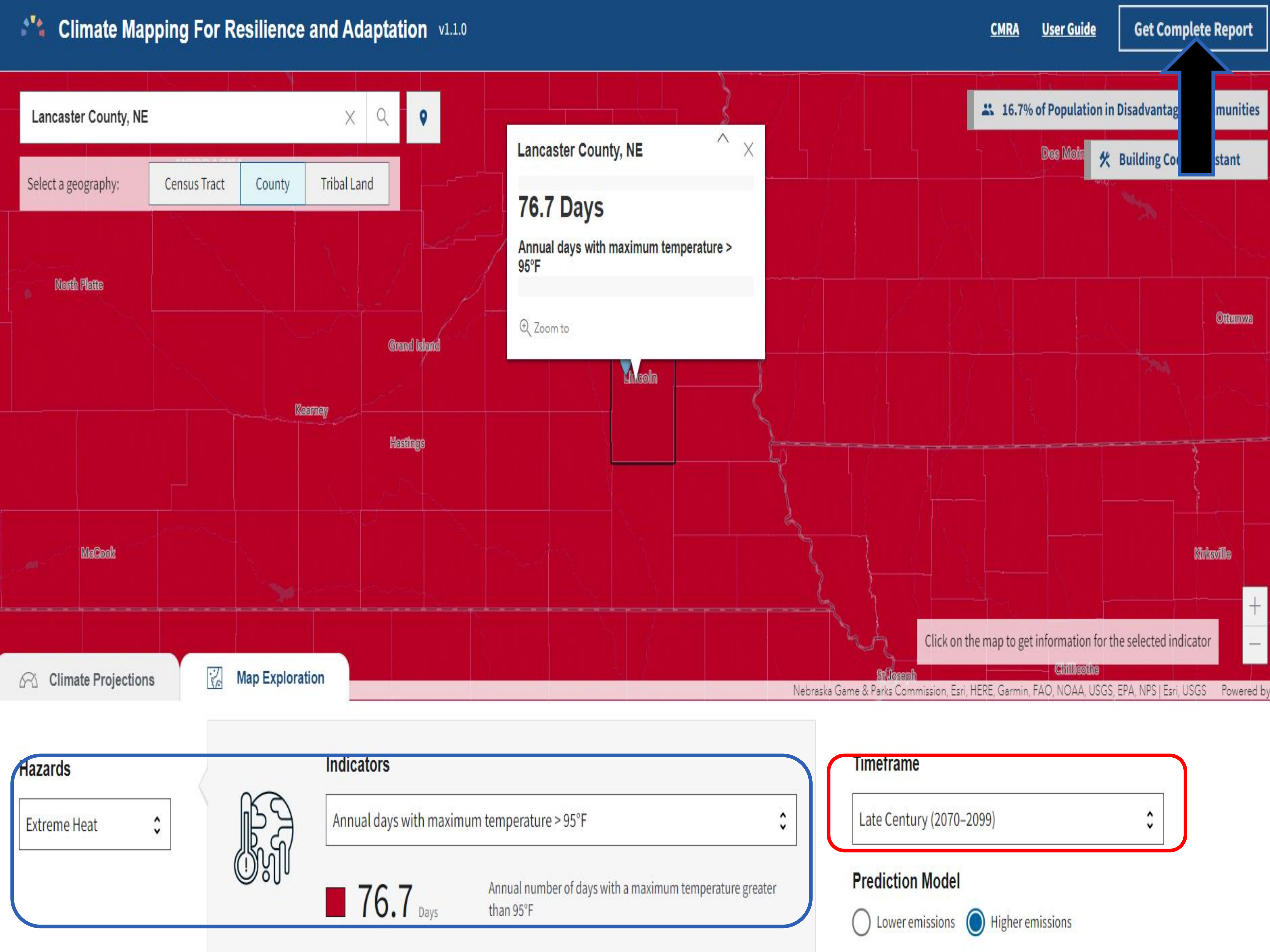
People under heat alerts **0**



Esri, Garmin, FAO, NOAA, USGS, EPA | Esri, USGS | Source: National Weather Service | NOAA, National Weather Service, Esri Powered by Esri

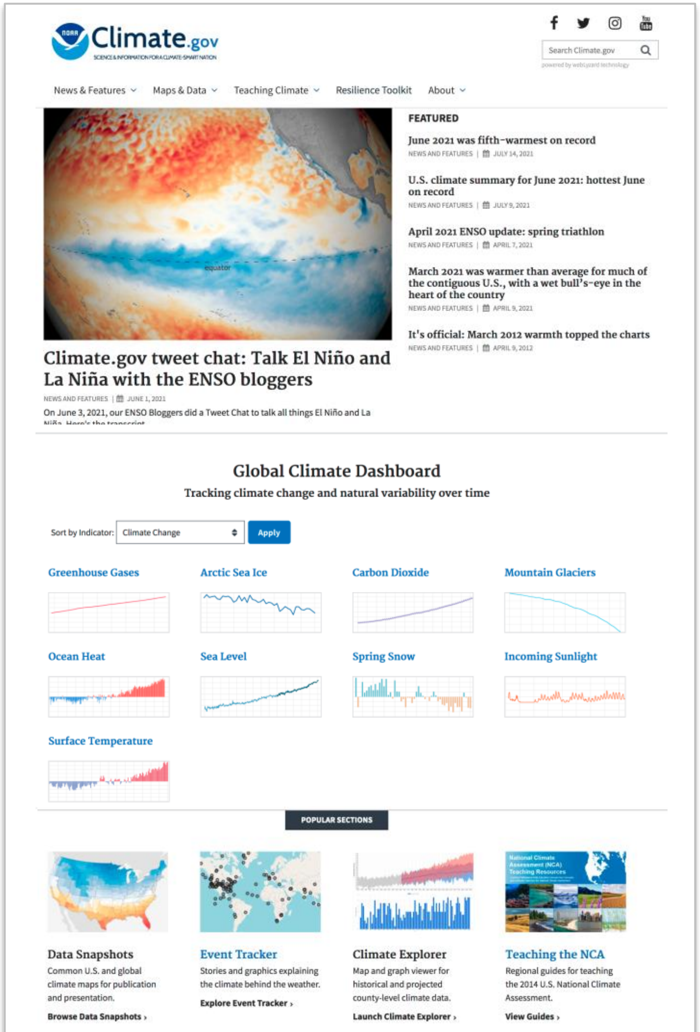


http://resilience.climate.gov

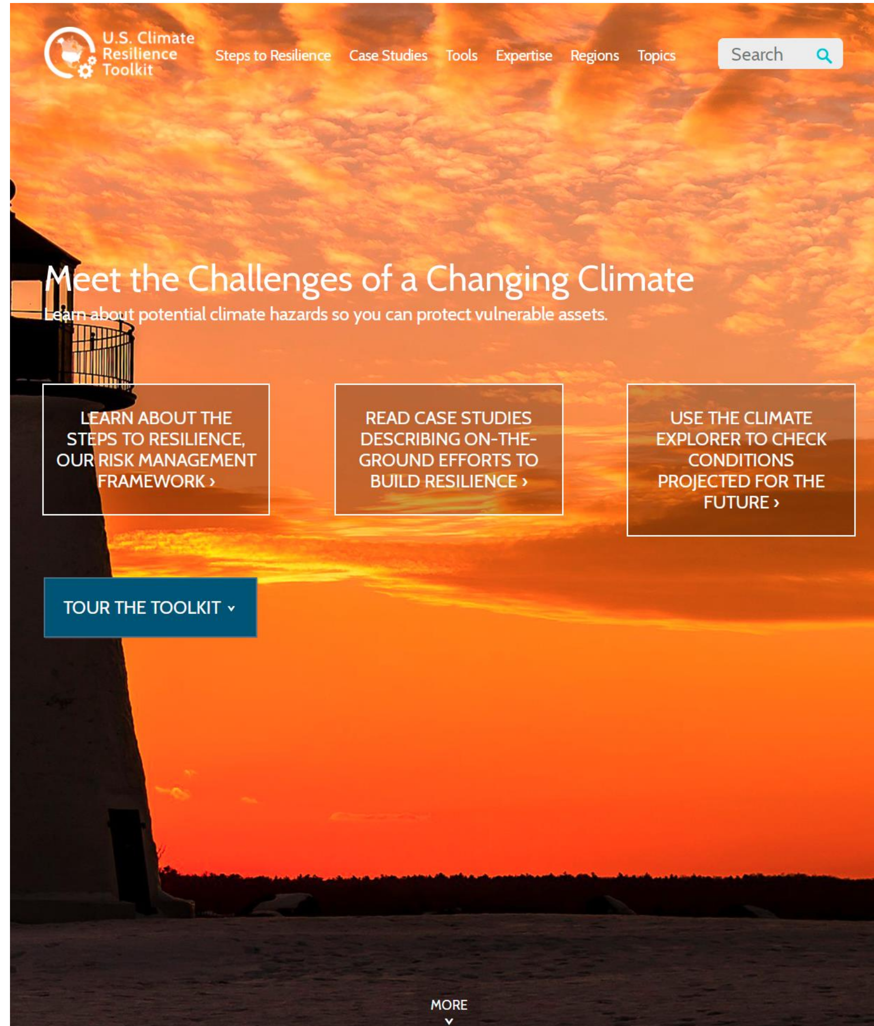

Climate Mapping For Resilience and Adaptation v1.1.0
CMRA
User Guide
Get Complete Report
Lancaster County, NE
Select a geography:
Census Tract
County
Tribal Land
16.7% of Population in Disadvantag munities
Building Co stant
Lancaster County, NE
76.7 Days
Annual days with maximum temperature > 95°F
Zoom to
North Platte
Grand Island
Kearney
Hastings
Lincoln
McCook
Des Moin
Ottumwa
Kirksville
St Joseph
Chillicothe
Click on the map to get information for the selected indicator
Nebraska Game & Parks Commission, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS | Esri, USGS
Powered by
Climate Projections
Map Exploration
Hazards
Extreme Heat
Indicators
Annual days with maximum temperature > 95°F
76.7 Days
Annual number of days with a maximum temperature greater than 95°F
Timeframe
Late Century (2070-2099)
Prediction Model
Lower emissions
Higher emissions

5-page reports are .html files that can be bookmarked, shared, or printed

Climate.gov, Drought.gov, Weather.gov, Heat.gov



www.climate.gov

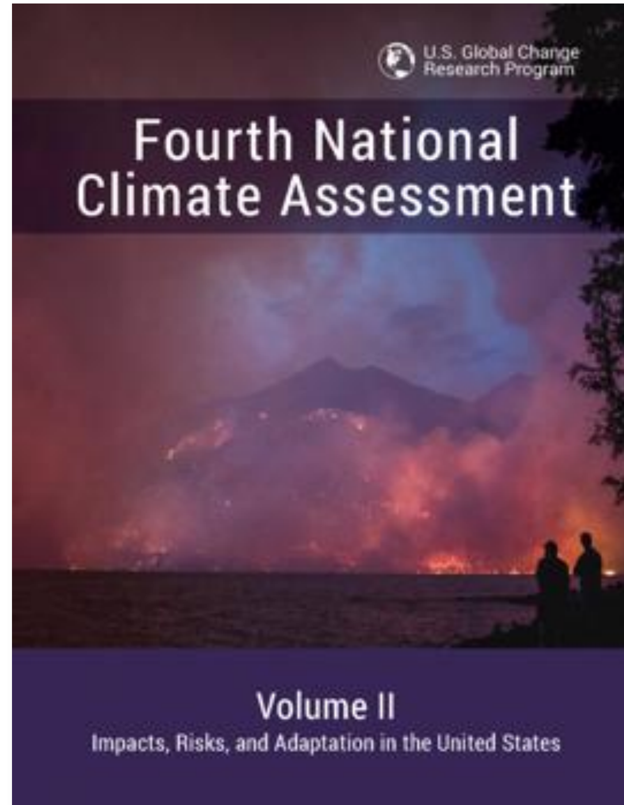


toolkit.climate.gov

Climate Resilience Toolkit: https://toolkit.climate.gov/

U.S. Global Change Research Program (USGCRP)

science2017.globalchange.gov

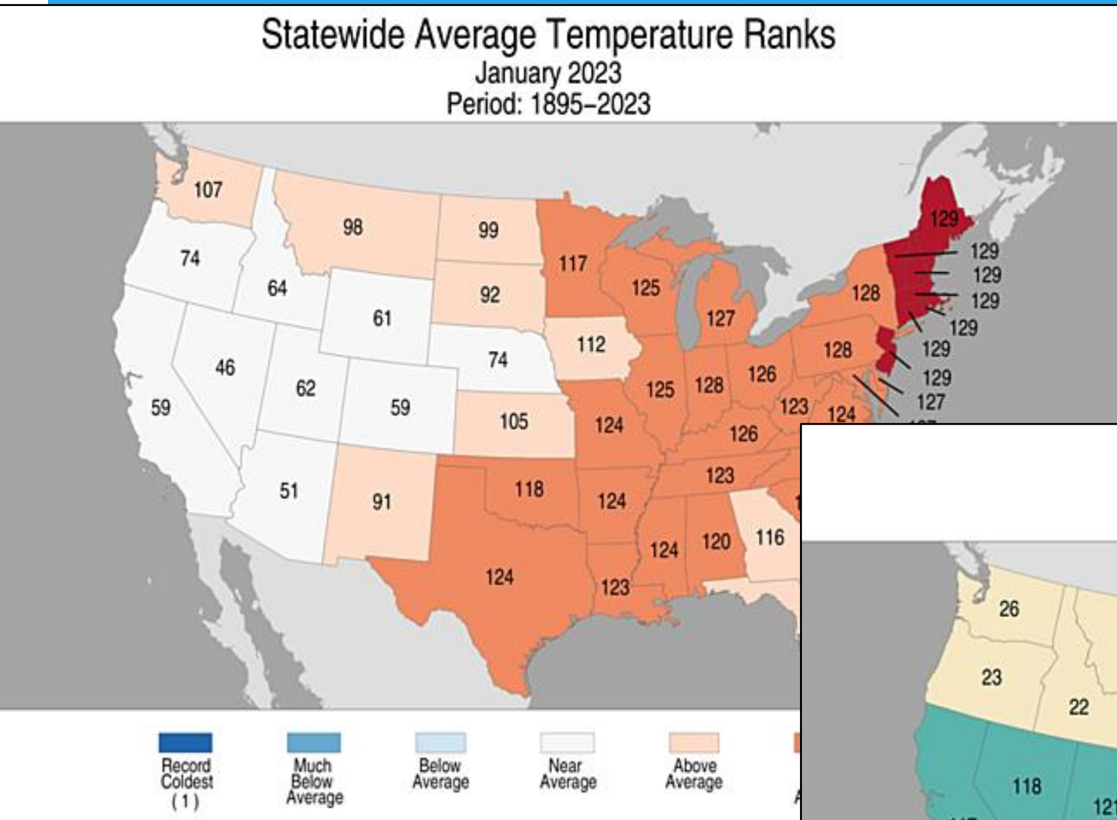


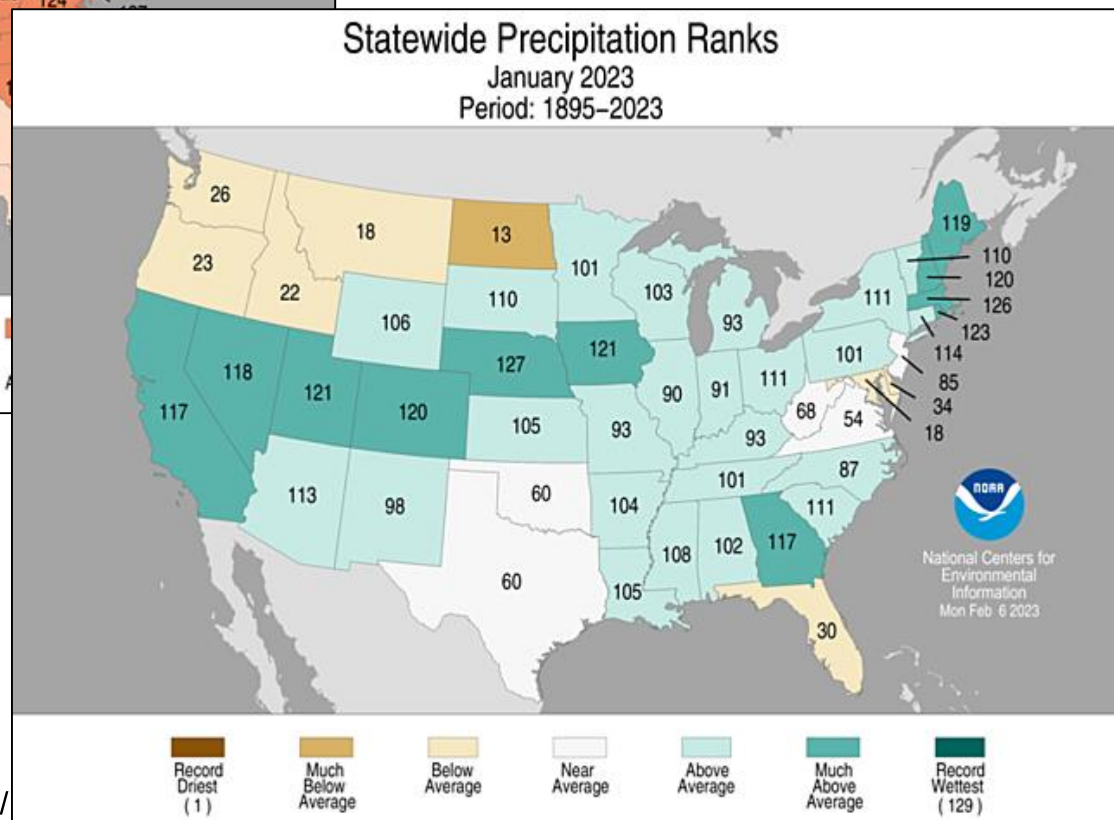
globalchange.gov/nca4

National Climate Assessment 5.0 due by the end of 2023

Local Trends, Current Conditions and Outlooks

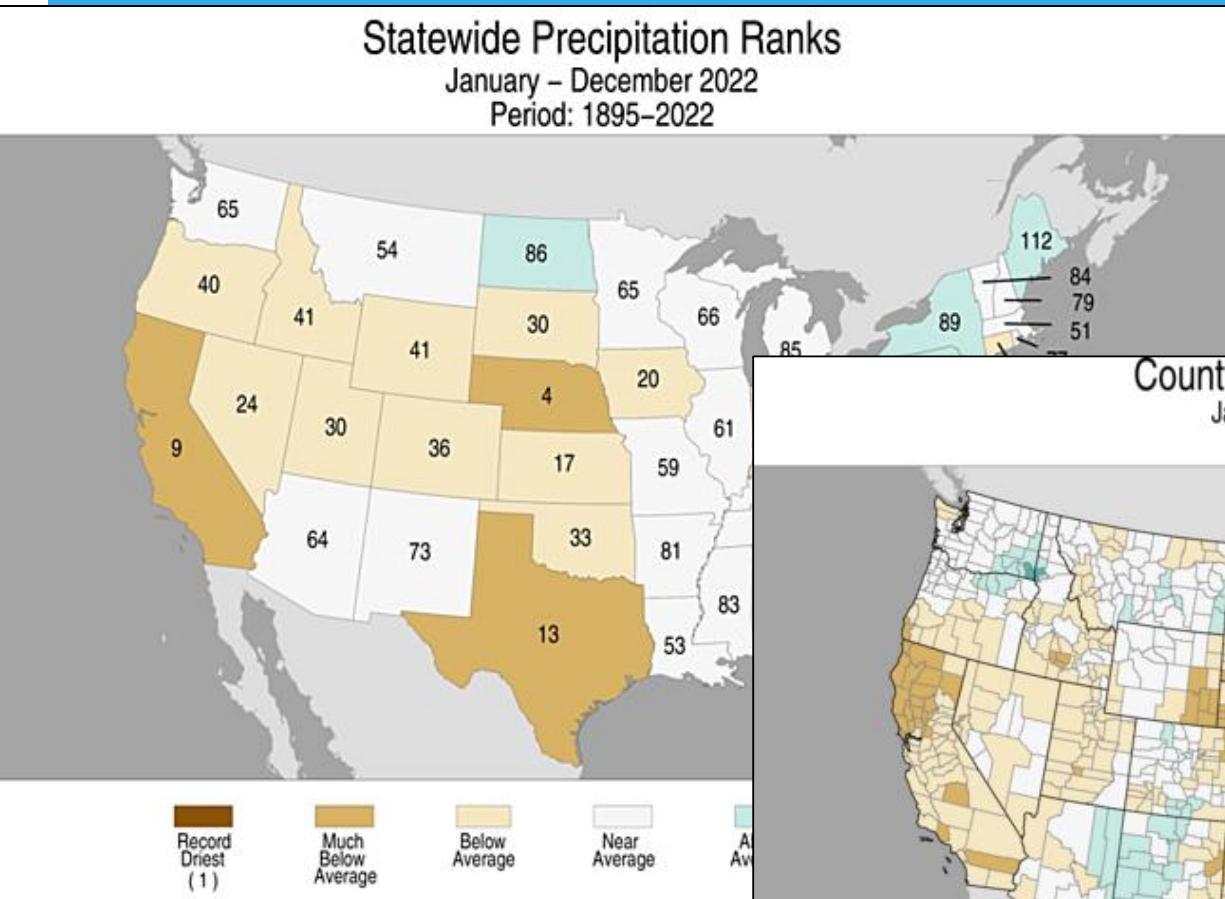
January 2023 Rankings



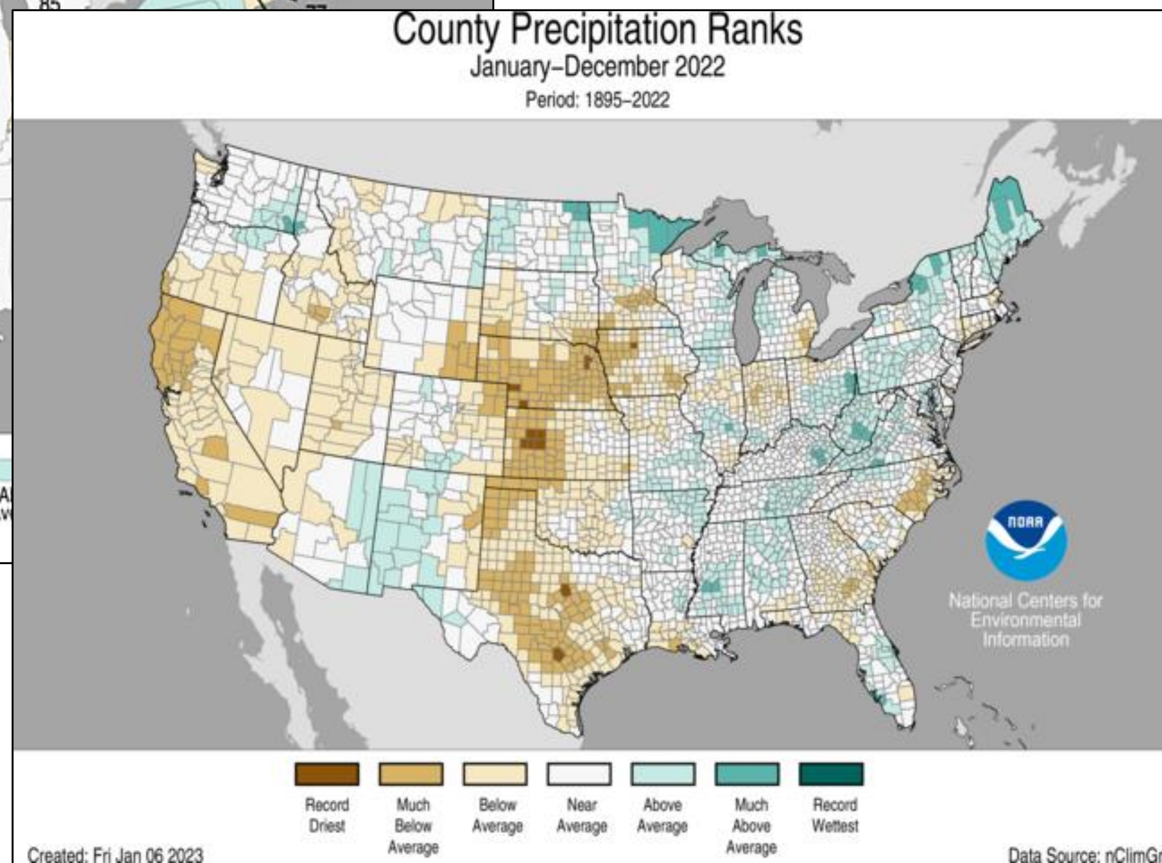


https://www.ncei.noaa.gov/access/monitoring/us-maps/

2022 Precipitation



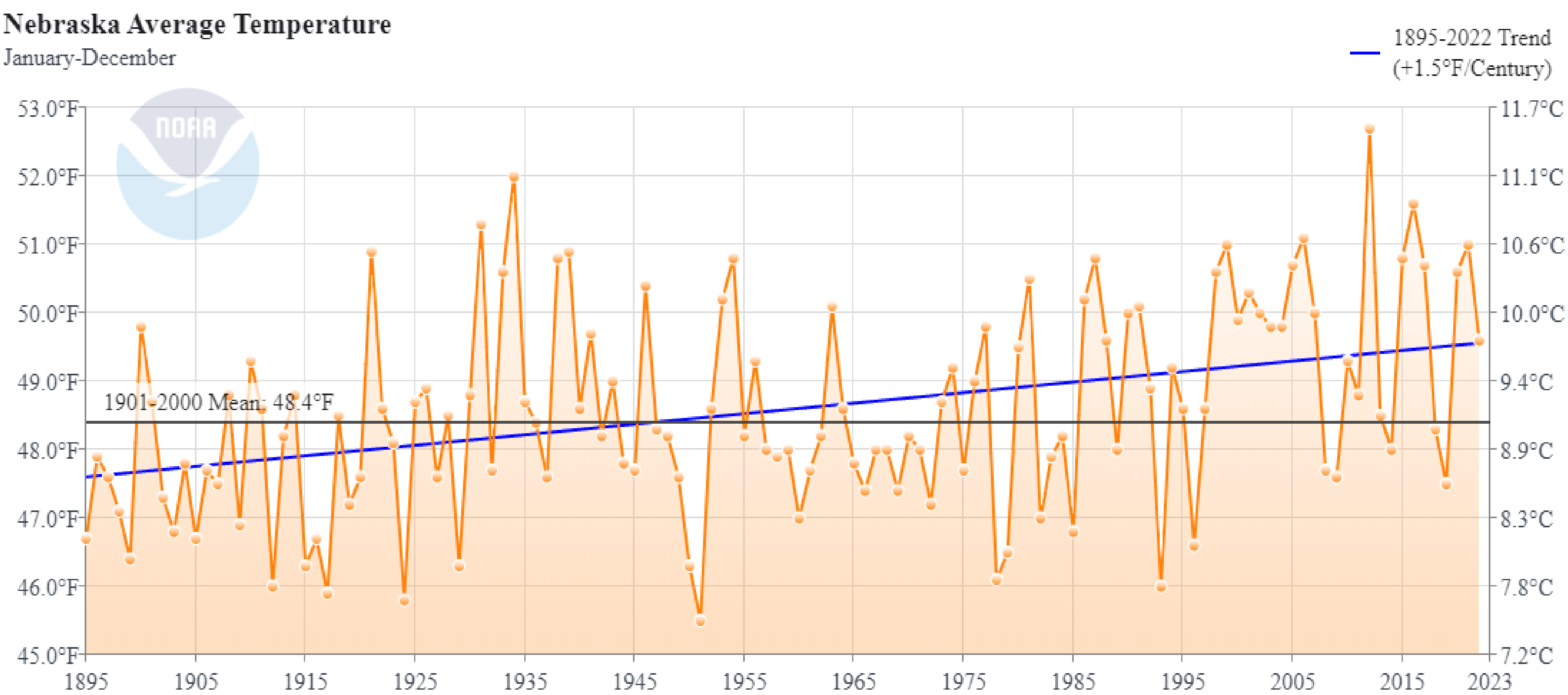
2022 - 2nd driest August - December



https://www.ncei.noaa.gov/access/monitoring/us-maps/

Nebraska Temperature Trends

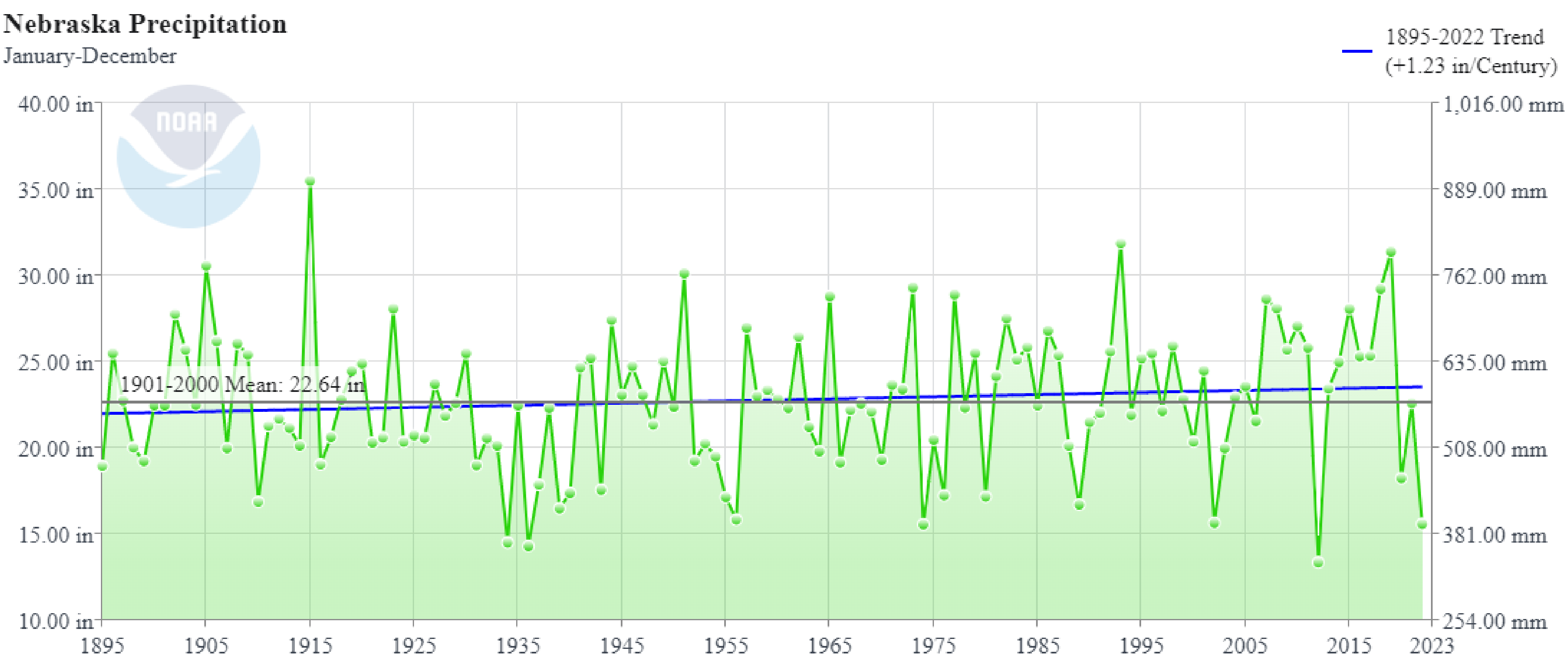
https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/



Panhandle: +2.2F/Century
Southeast: +1.3F/Century

Nebraska Precipitation Trends

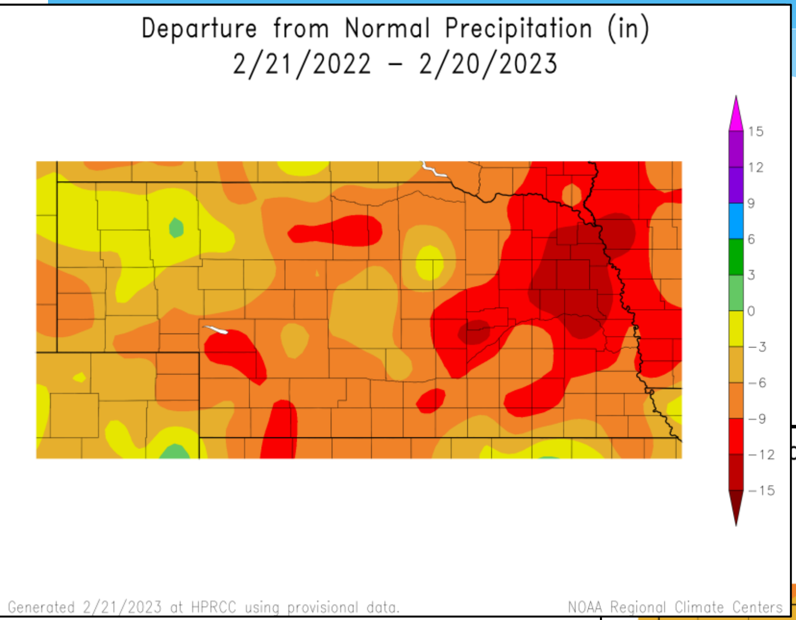
https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/



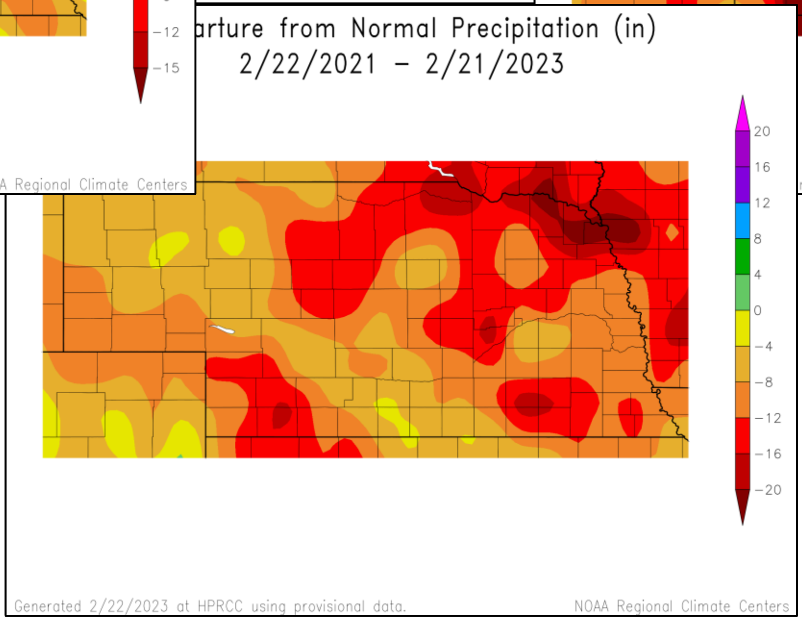
Southeast: +1.36"
Panhandle: +0.14

Have precipitation increases been able to keep up with rising temperatures?

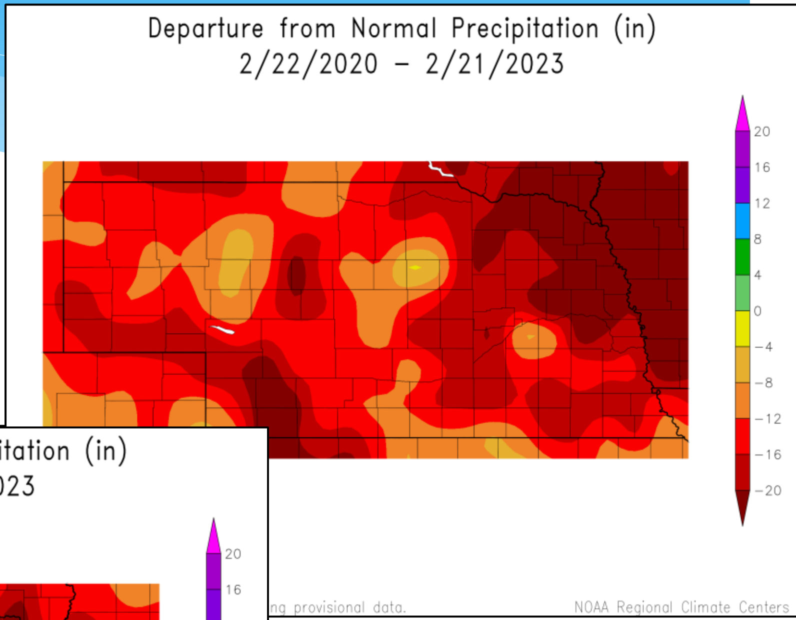
Precipitation % of Normal and deficit: Last 3, 2 and 1 years



12 Months



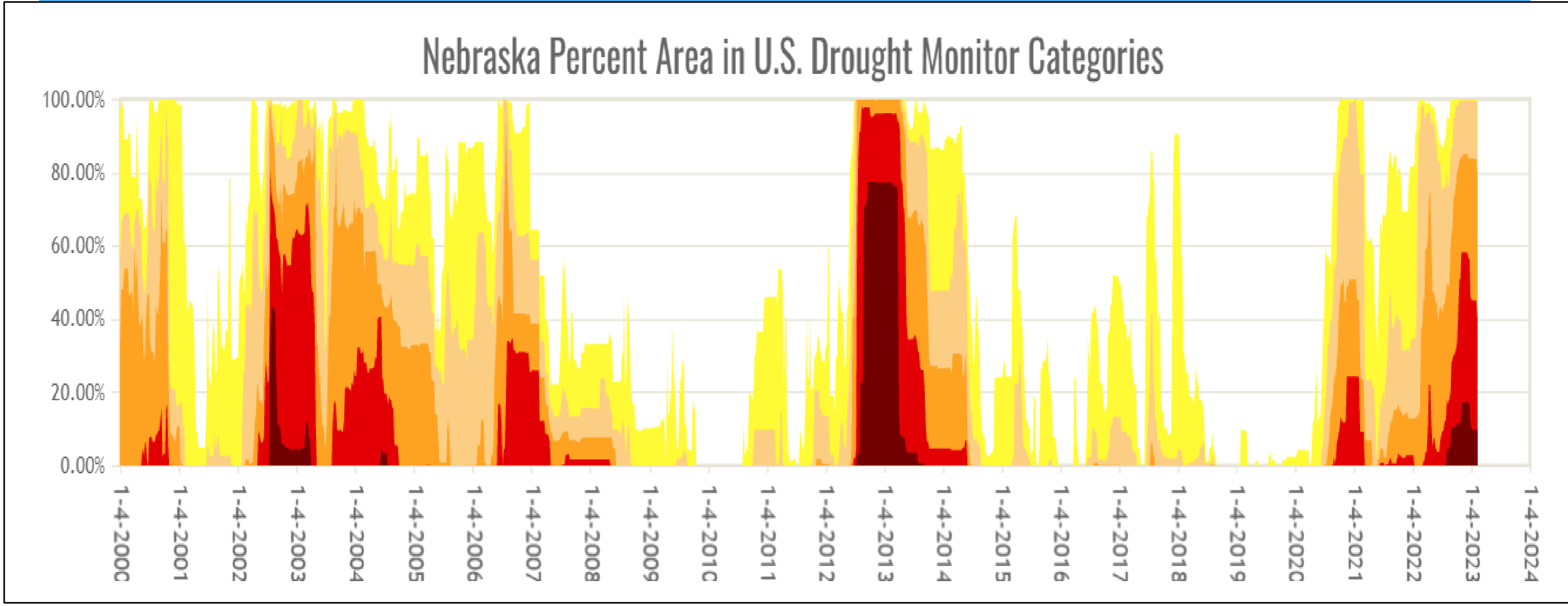
24 Months



36 Months

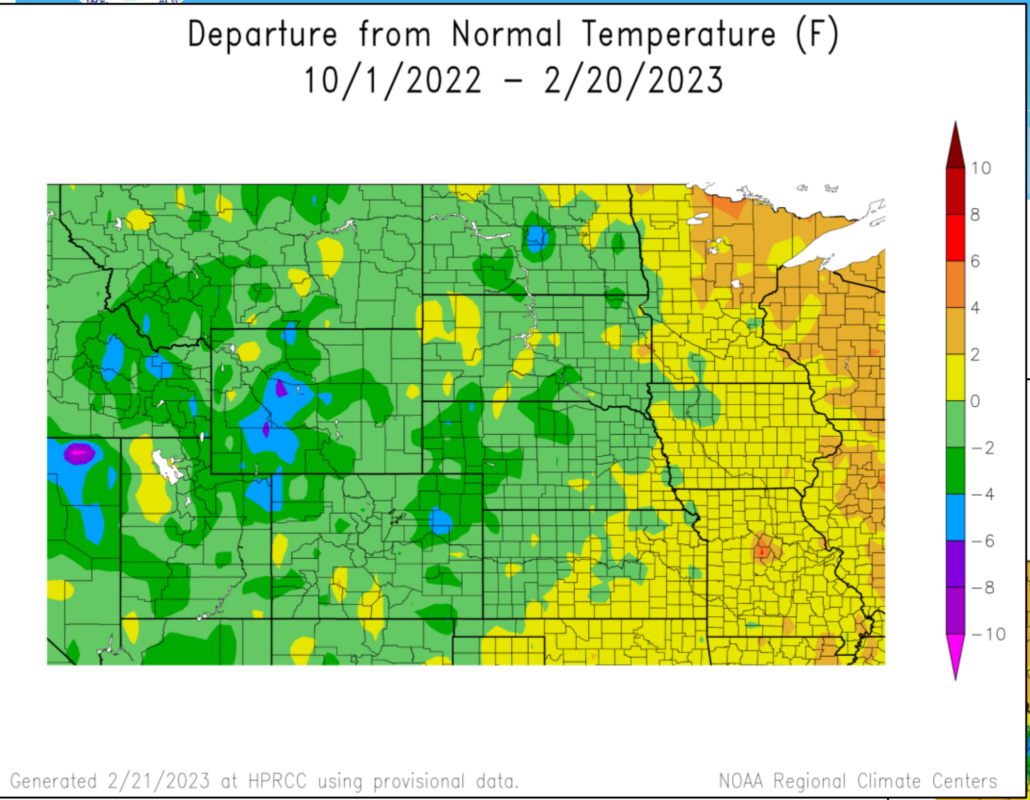
https://hprcc.unl.edu/maps.php?map=ACISClimateMaps

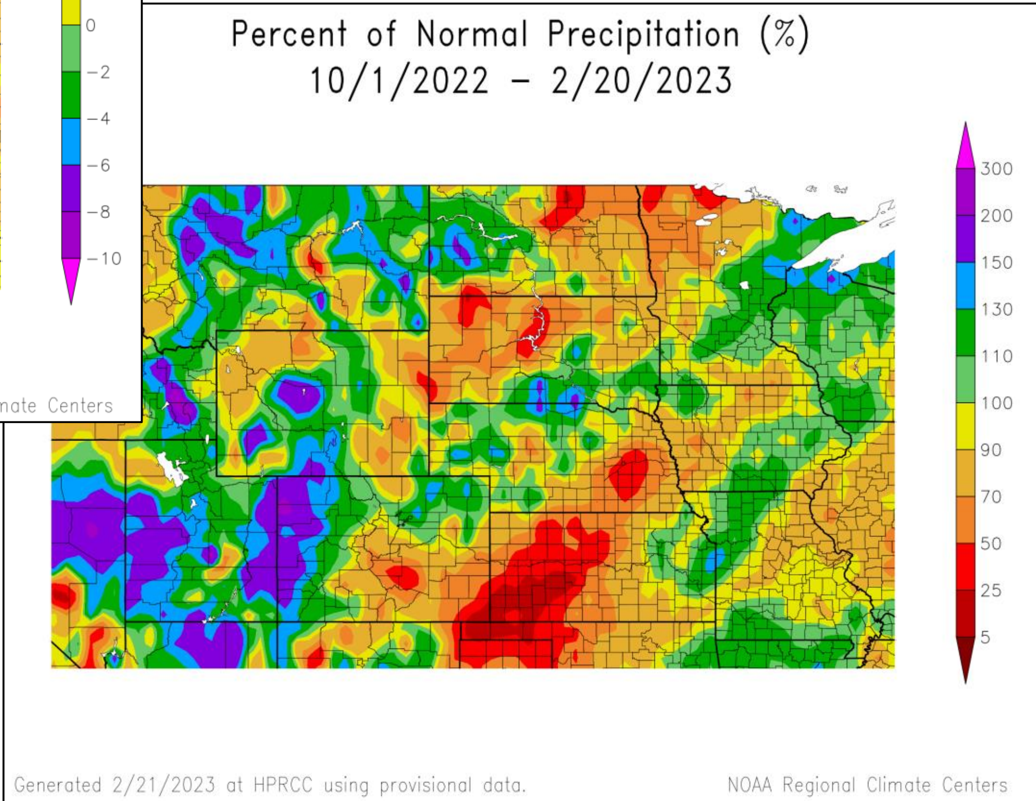
22 Years of Drought: Nebraska



https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx

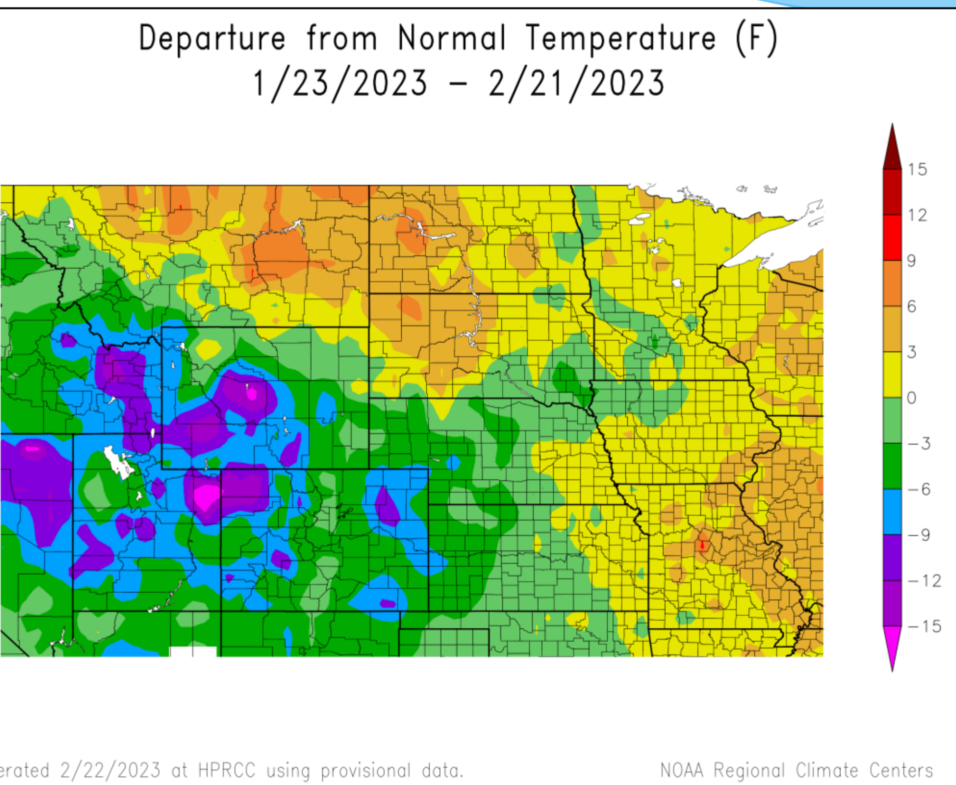
Temperature & Precipitation
Since October 1st, 2022

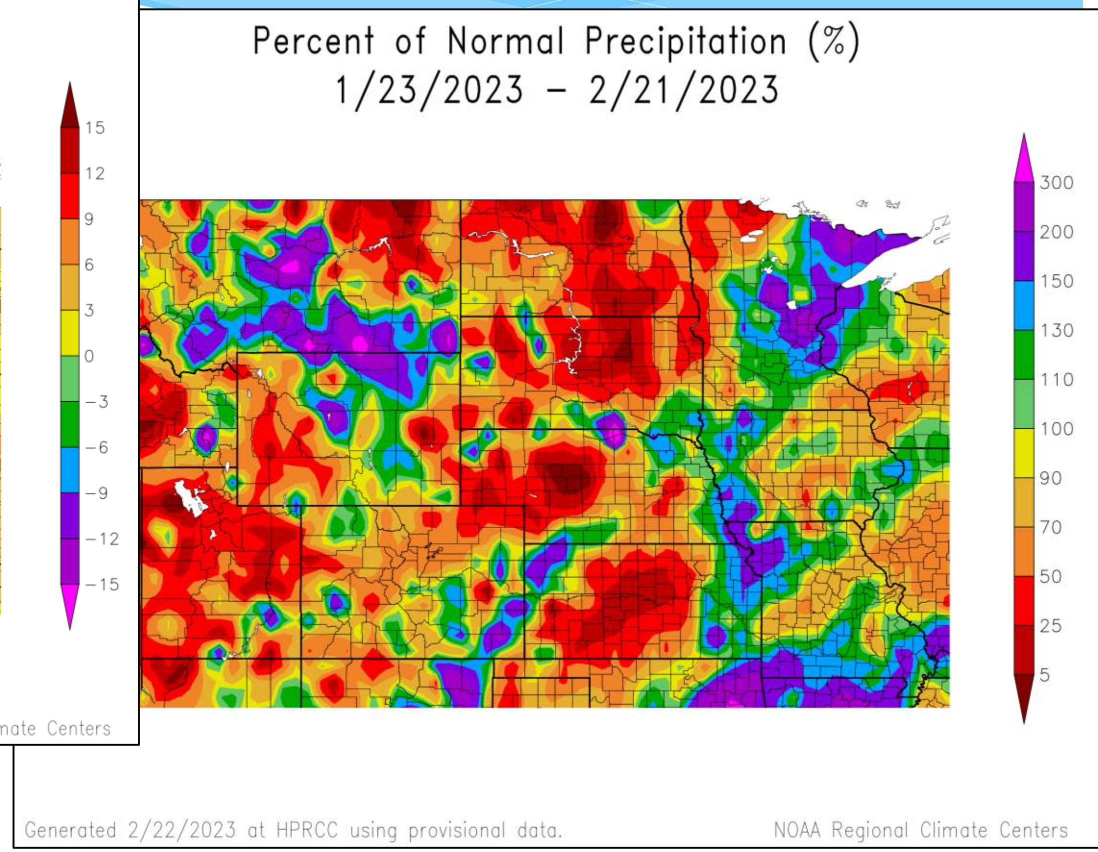




https://hprcc.unl.edu/maps.php?map=ACISClimateMaps

Temperature & Precipitation
Last 30 days

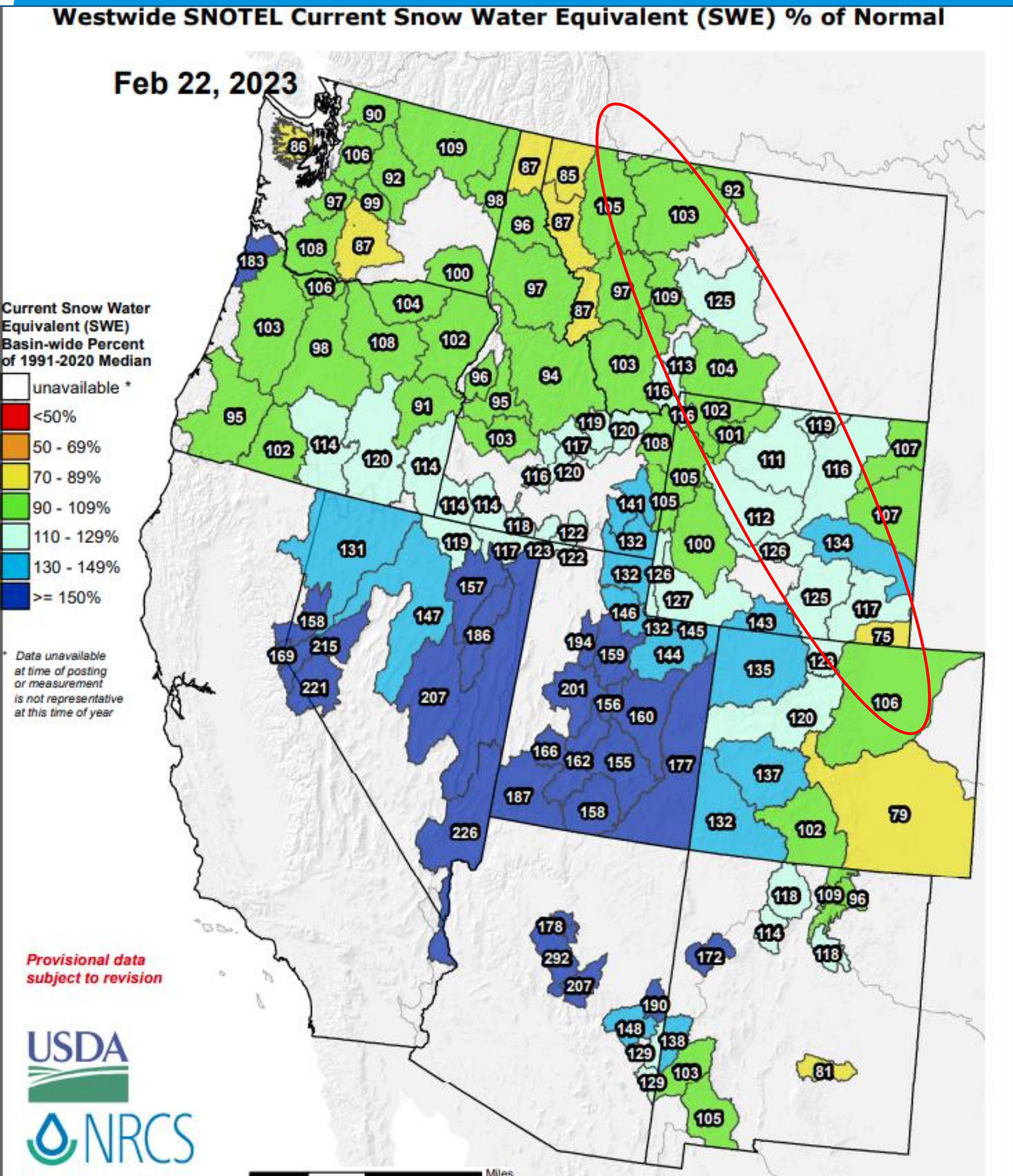




http://www.hprcc.unl.edu/maps/current/index.php

Mountain Snowpack

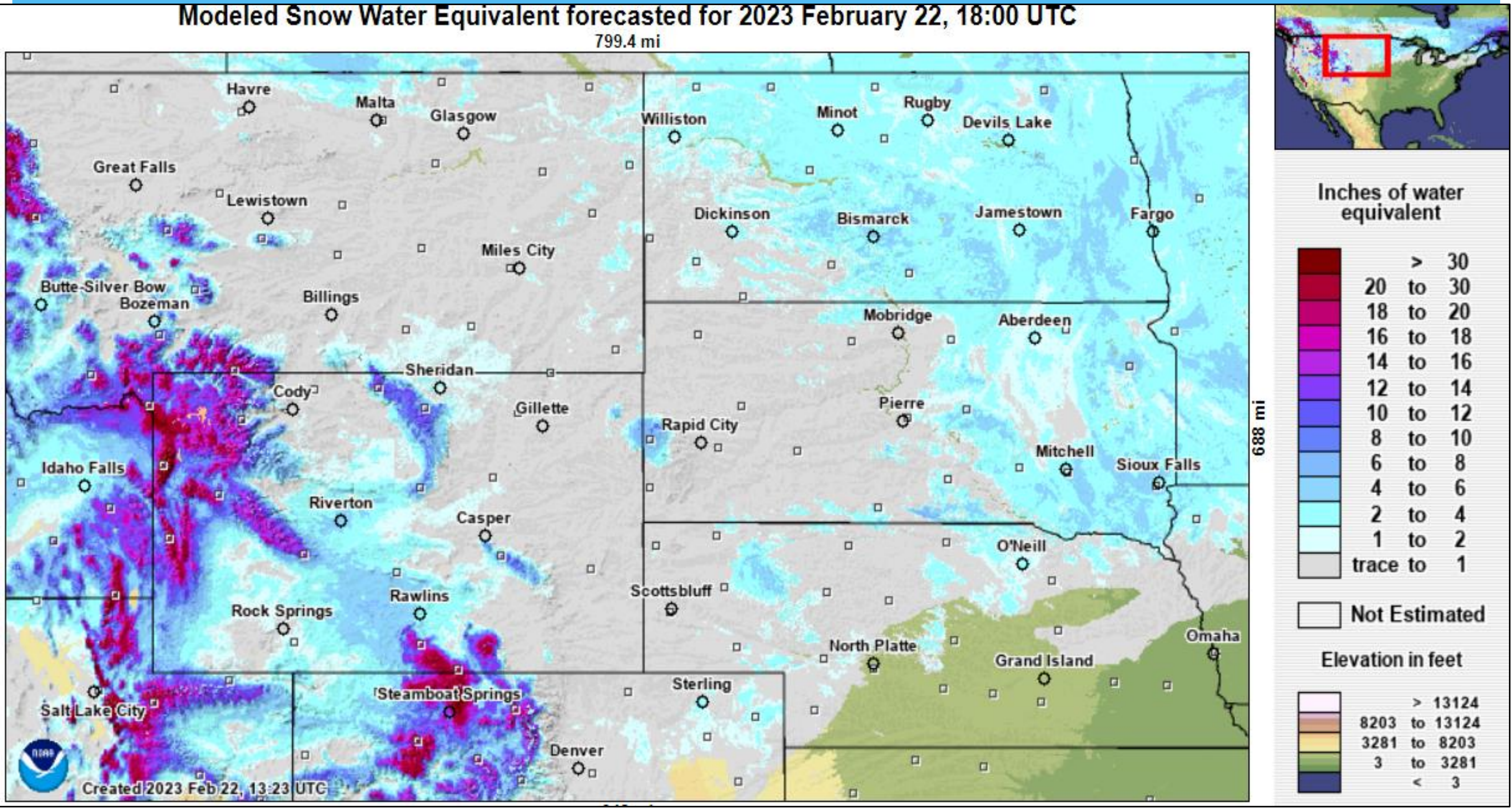
(snow water equivalent % of normal)



https://www.wcc.nrcs.usda.gov/ftpref/data/water/wcs/gis/maps/west_swepctnormal_update.pdf

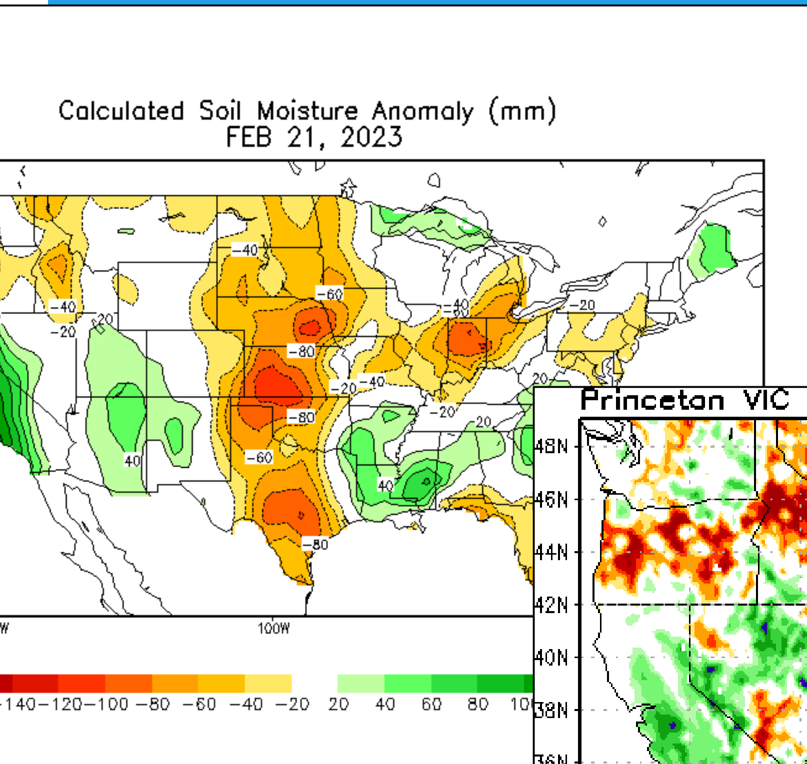
Plains Snowpack (snow water equivalent)

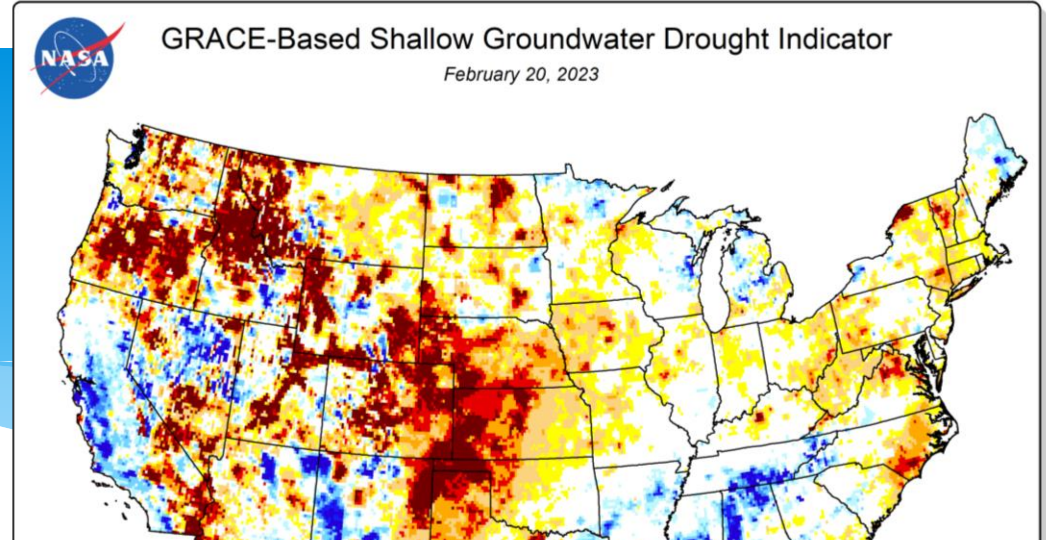
(February 22, 2023)

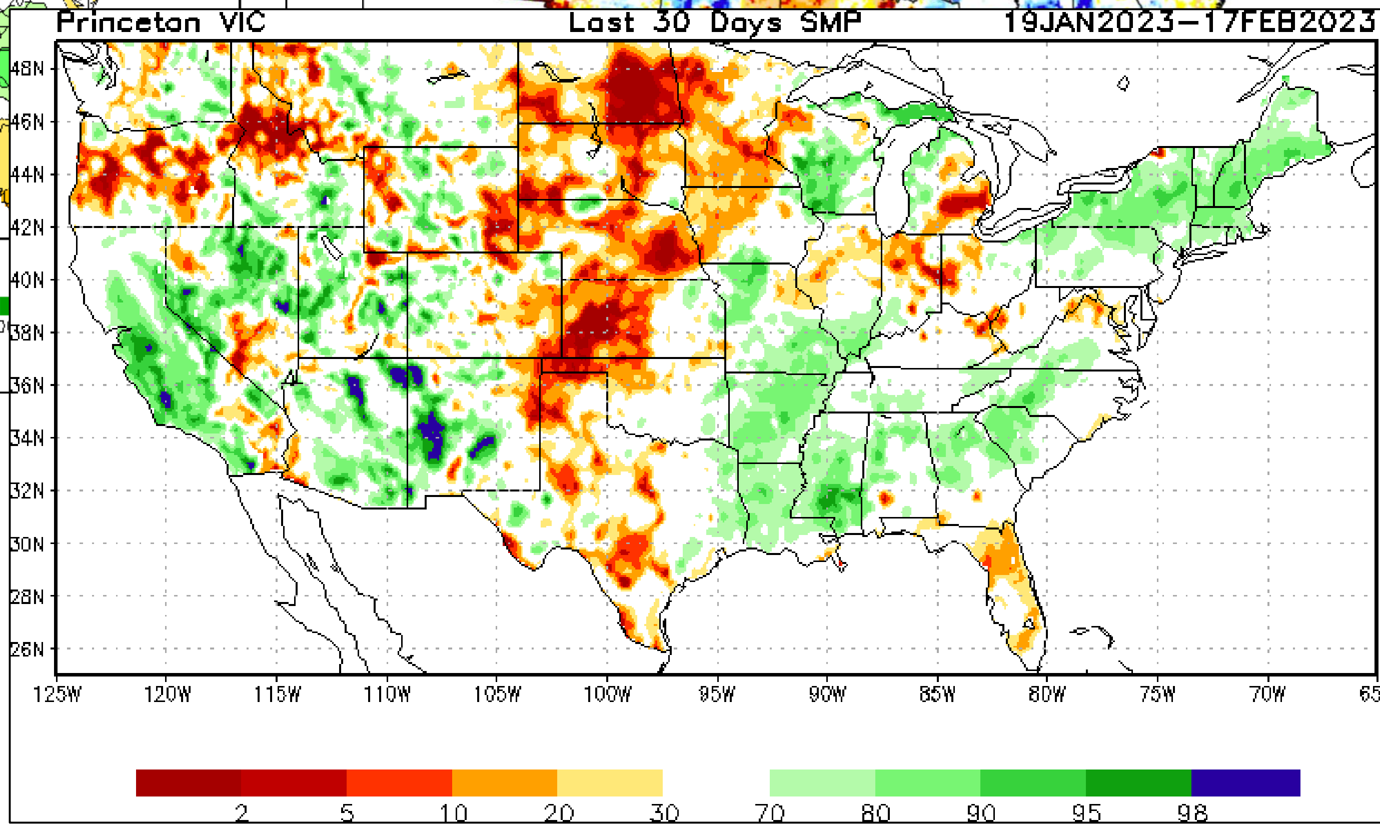


http://www.nohrsc.noaa.gov

Soil Moisture

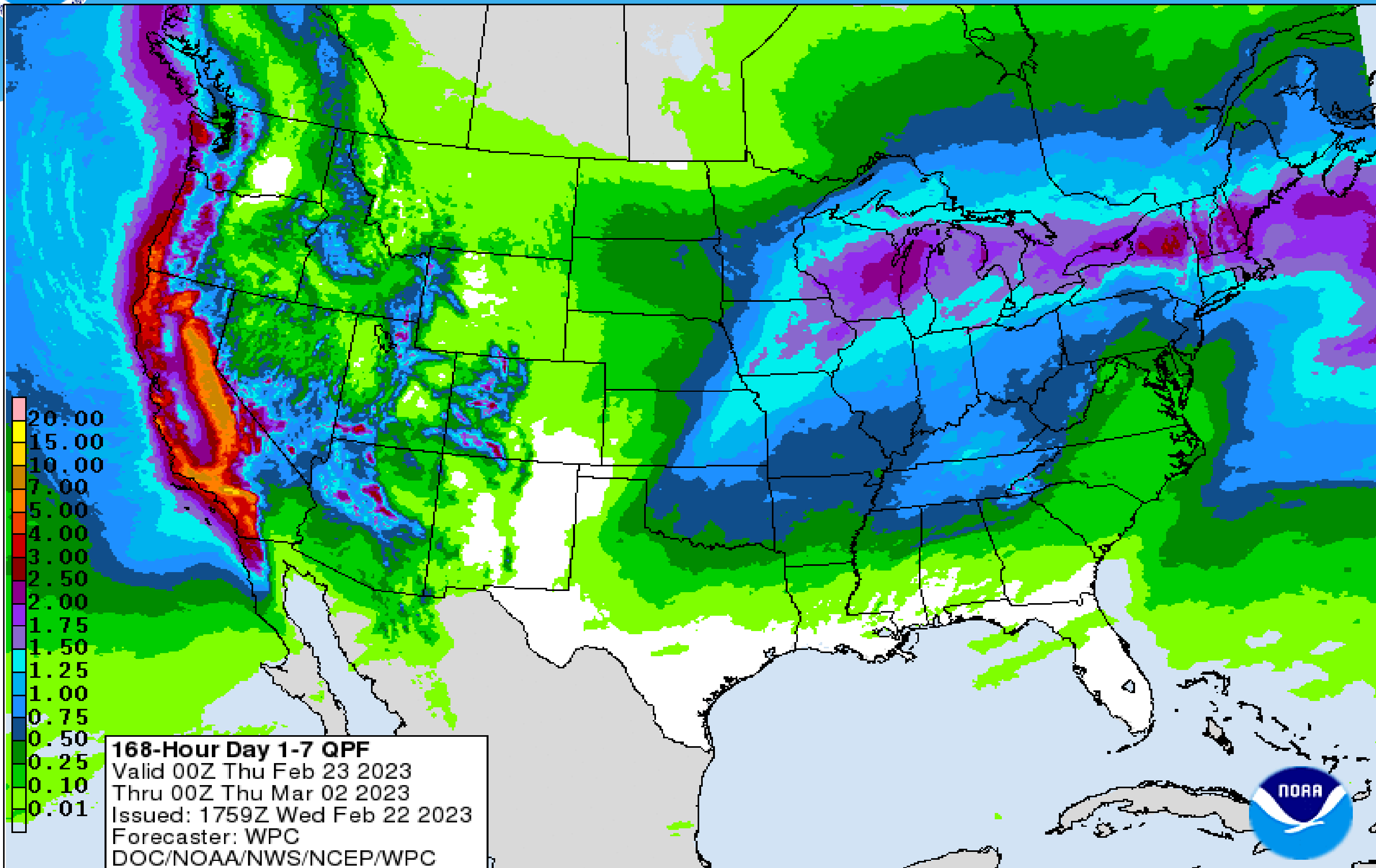






https://weather.msfc.nasa.gov/sport/case_studies/lis_CONUS.html

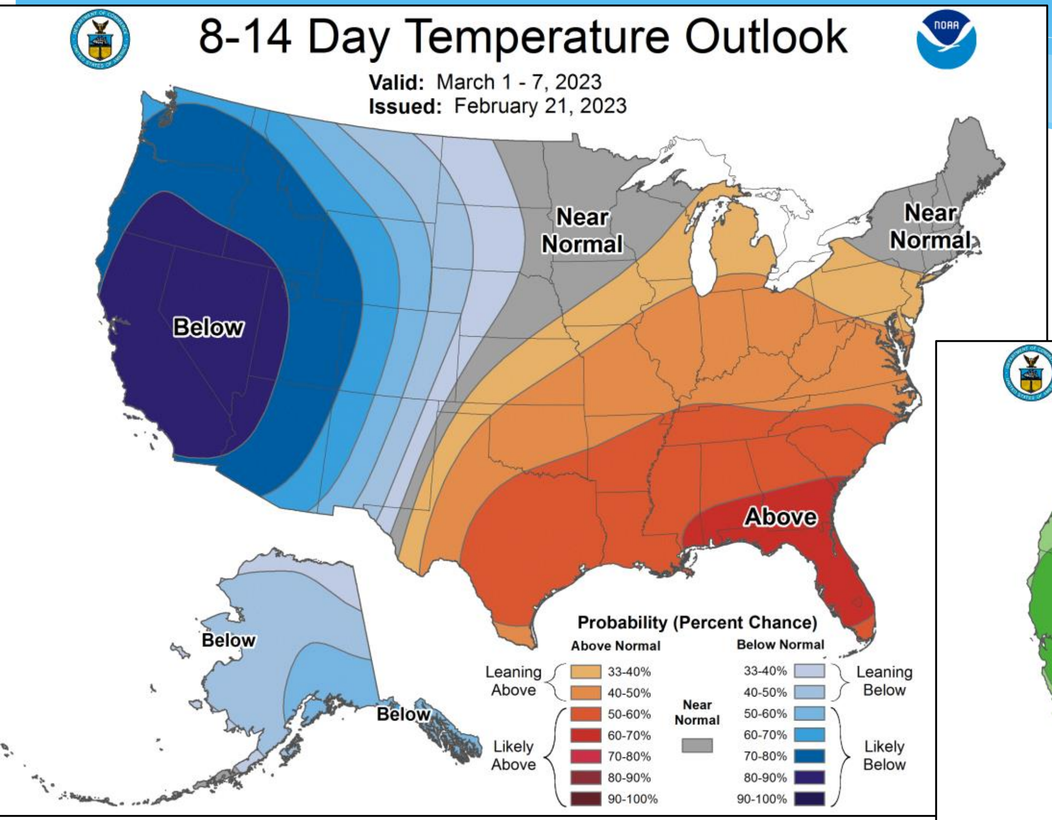
Total Precipitation Outlook Through 3/2/23

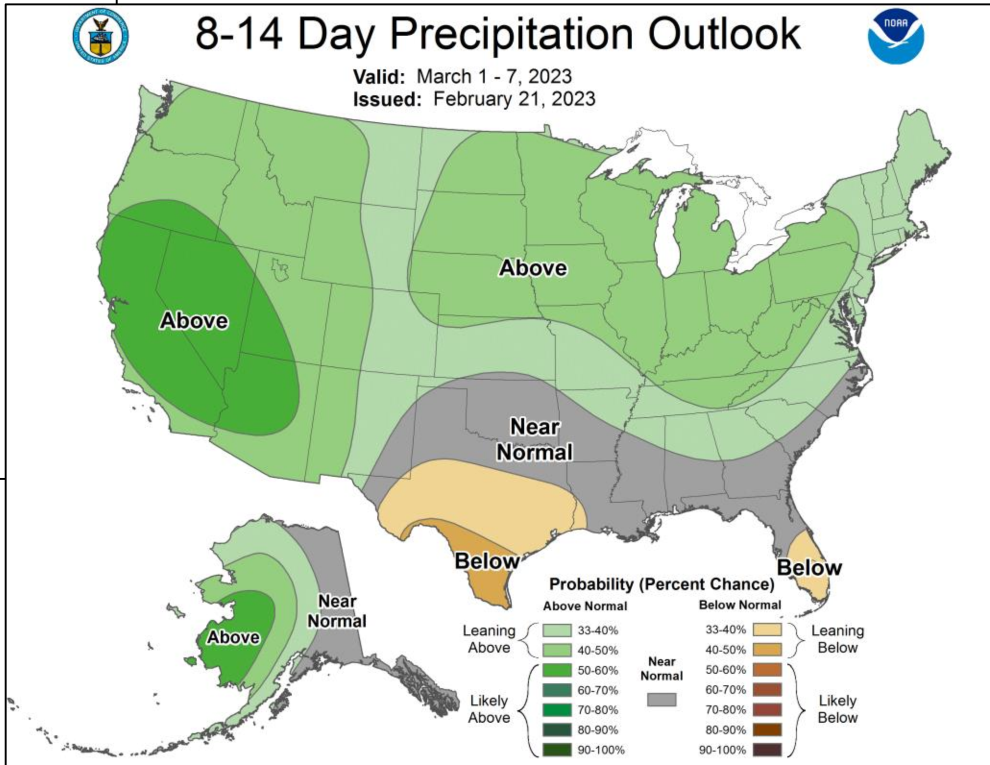


https://www.wpc.ncep.noaa.gov/qpf/day1-7.shtml

Week 2 Temperature & Precipitation Outlook

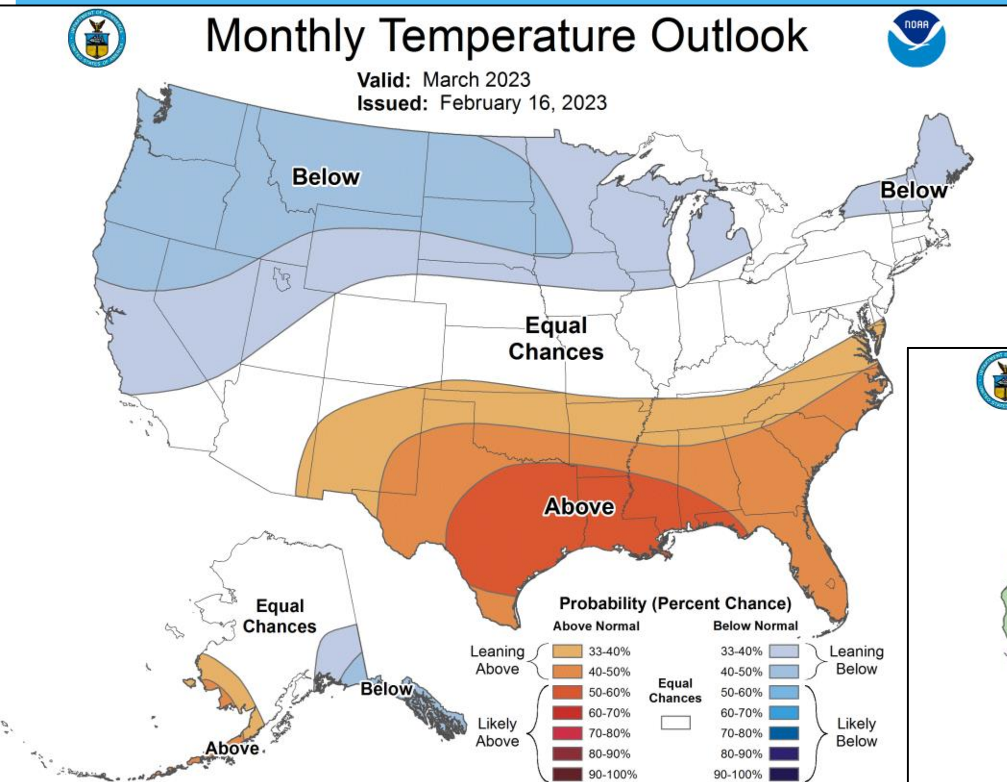
(March 1st – 7th, 2023)

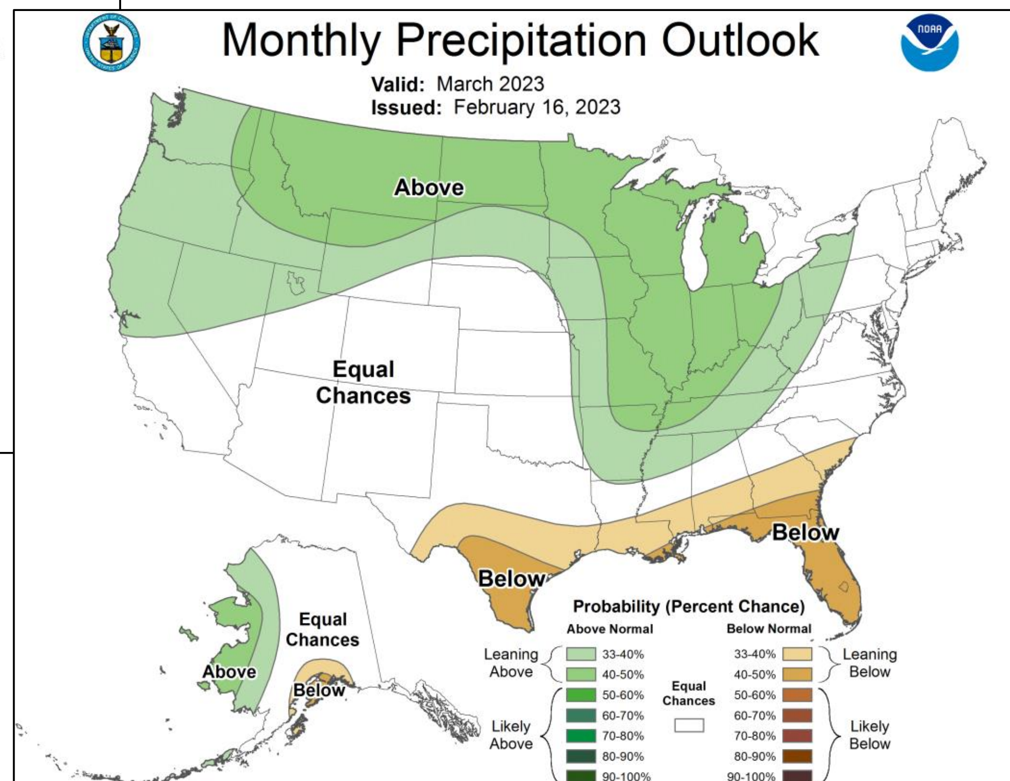




http://www.cpc.noaa.gov/

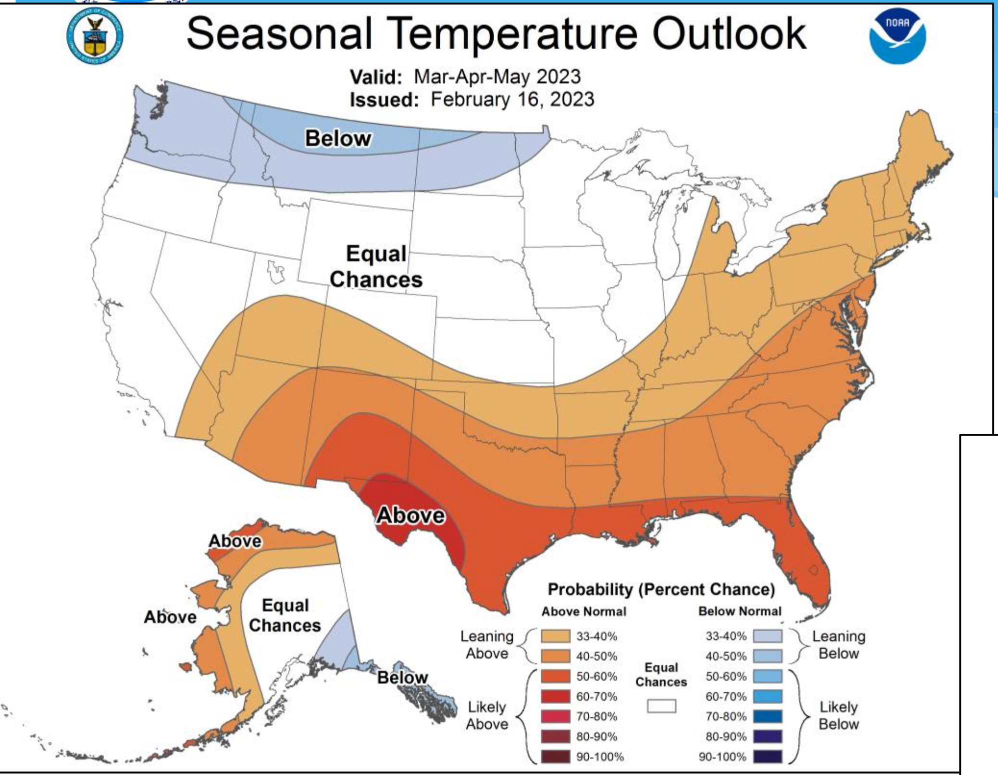
March 2023 Temperature & Precipitation Outlook

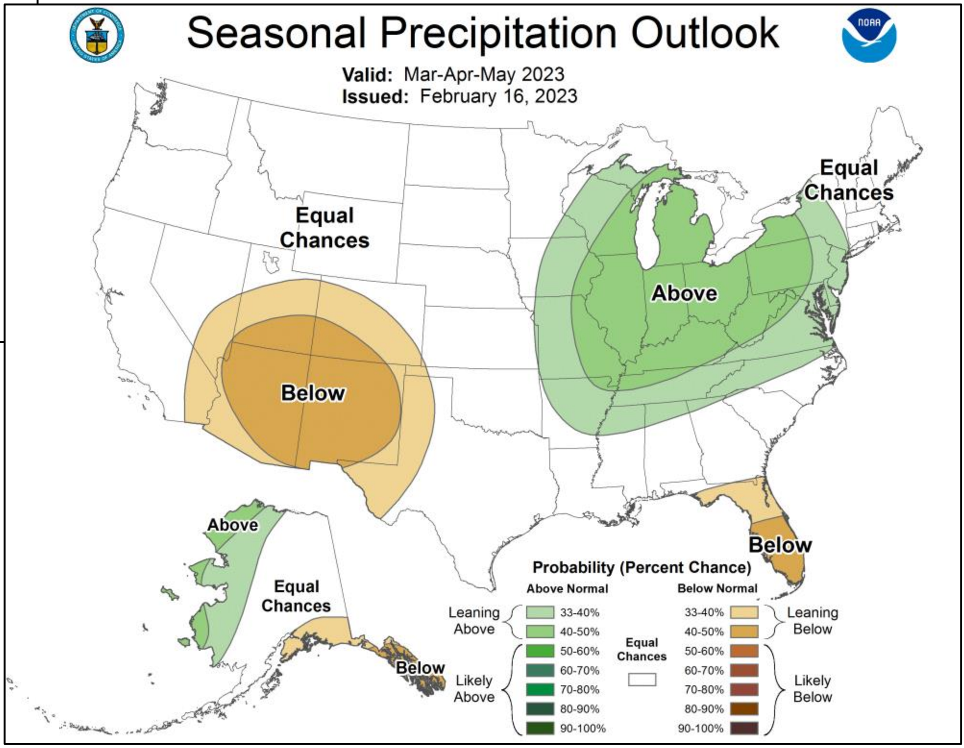




http://www.cpc.noaa.gov/

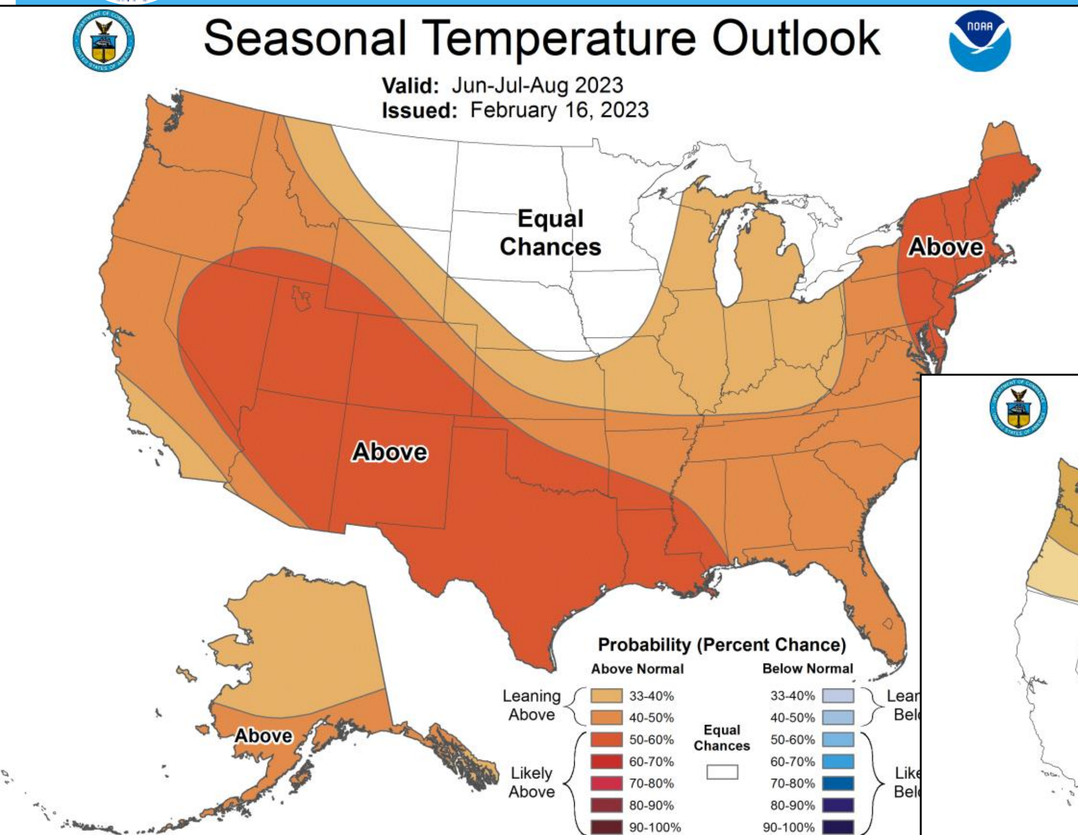
March - May 2023 Temperature & Precipitation Outlook

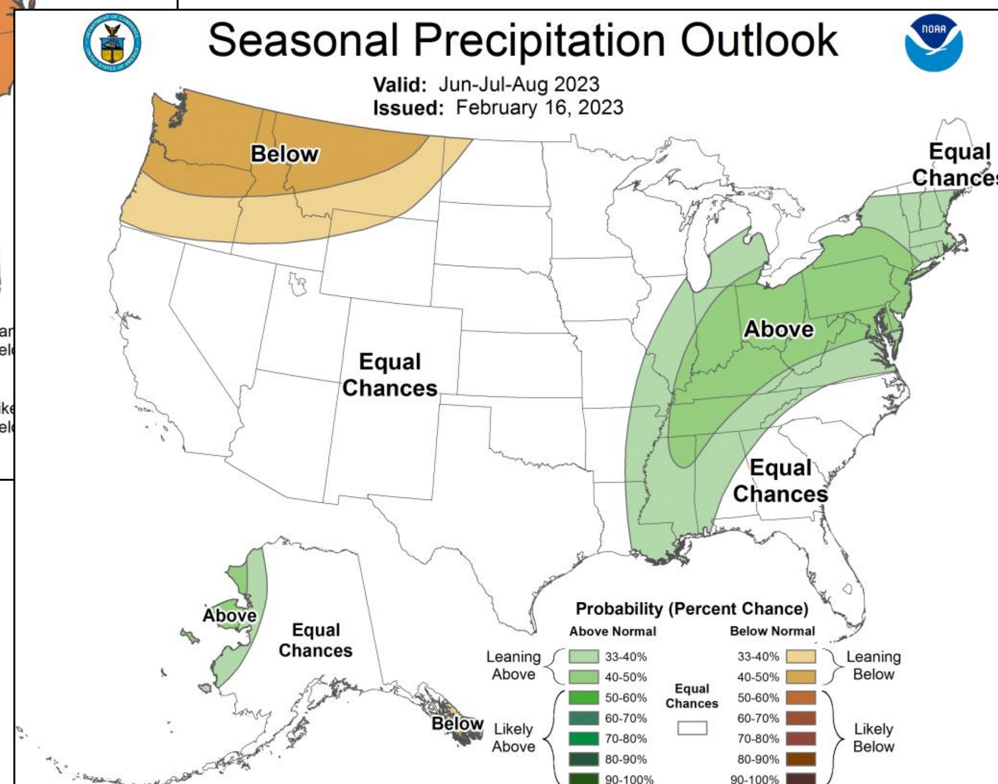




http://www.cpc.noaa.gov/

June - August 2023 Temperature & Precipitation Outlook



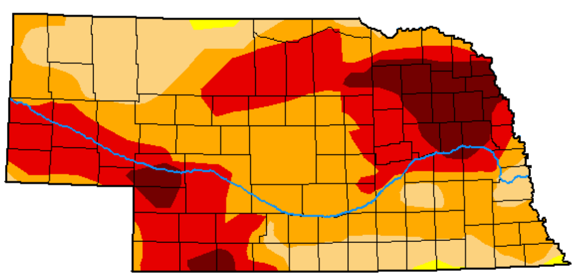


http://www.cpc.noaa.gov/

Drought Update

U.S. Drought Monitor
Nebraska

February 14, 2023
(Released Thursday, Feb. 16, 2023)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.21	79.82	40.07	9.97
Last Week 02-07-2023	0.00	100.00	99.71	83.88	45.13	9.97
3 Months Ago 11-15-2022	0.00	100.00	99.78	84.62	58.39	17.37
Start of Calendar Year 01-03-2023	0.00	100.00	99.78	83.95	46.30	12.35
Start of Water Year 09-27-2022	0.00	100.00	94.94	74.27	30.52	10.50
One Year Ago 02-15-2022	0.16	99.84	91.20	14.09	0.00	0.00

Intensity:

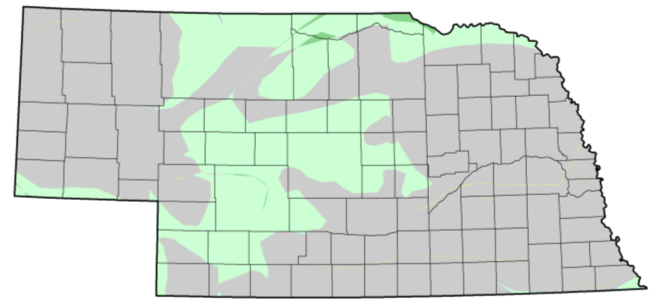
- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Brian Fuchs
National Drought Mitigation Center

droughtmonitor.unl.edu

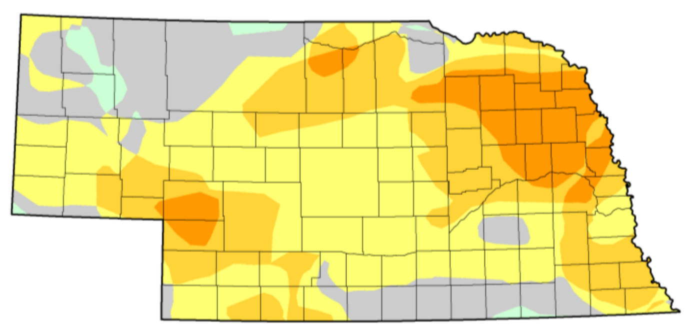
U.S. Drought Monitor Class Change - Nebraska
8 Week



February 14, 2023 compared to December 20, 2022

droughtmonitor.unl.edu

U.S. Drought Monitor Class Change - Nebraska
52 Week

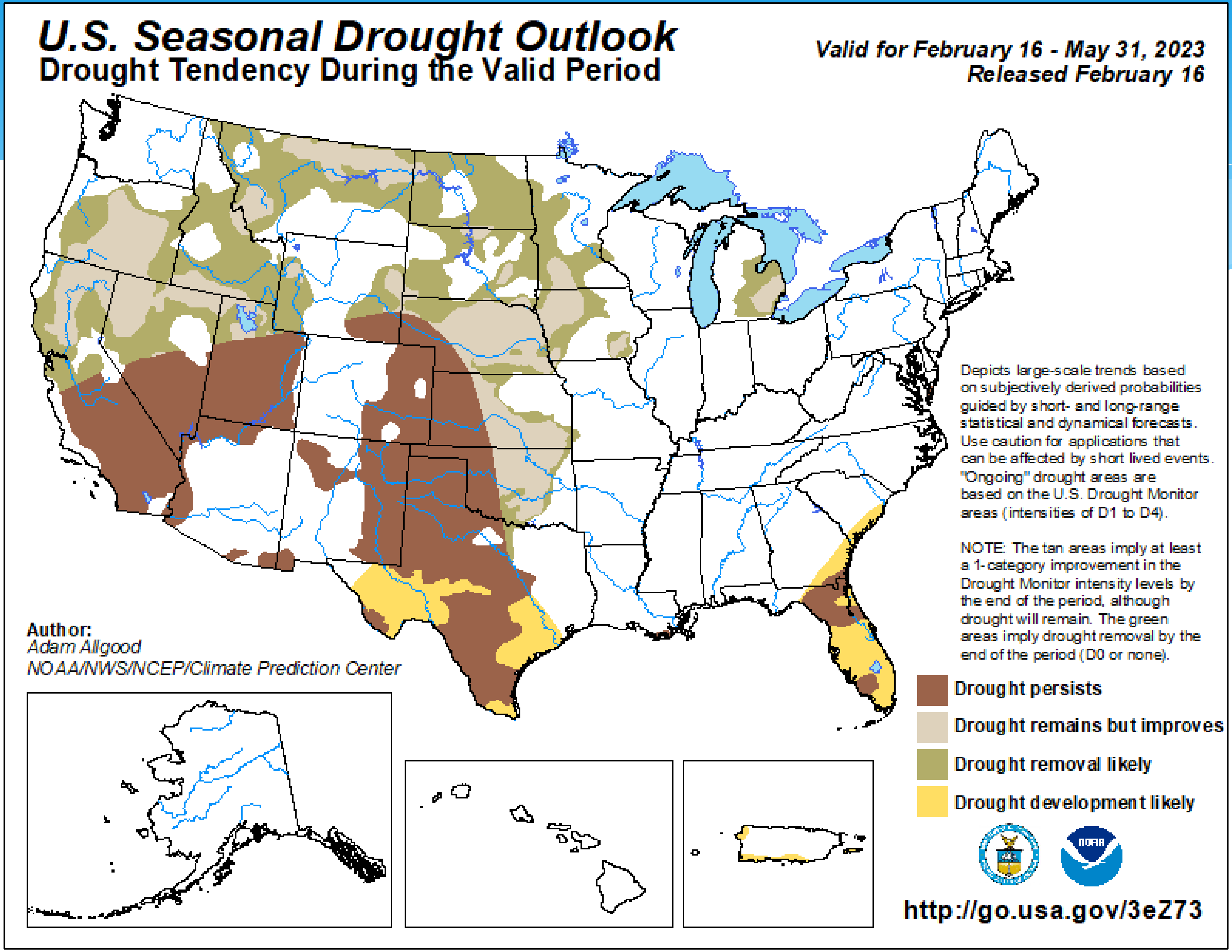


February 14, 2023 compared to February 15, 2022

droughtmonitor.unl.edu

https://www.drought.gov/drought/

Drought Outlook through May 2023



https://www.cpc.ncep.noaa.gov/

Key Points

- **Current Conditions**
  - Current ENSO condition: **La Niña transitioning to Neutral this spring then El Niño?**
  - Plains snowpack decent so far
  - Mountain snowpack mainly slightly above average
- **Outlook**
  - Short term (week 2):
    - Temperatures near normal
    - Precipitation favors above normal
  - Long term:
    - Temperatures mainly equal chances of above/below/normal
    - Precipitation mainly equal chances

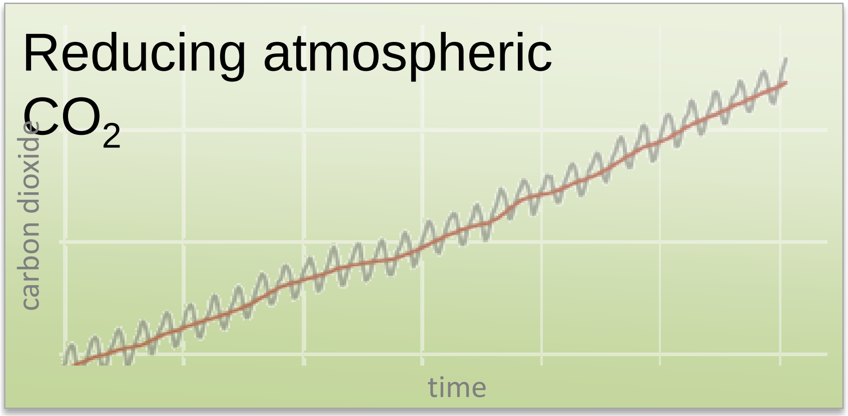
Next monthly North Central Climate Summary & Outlook Webinar, March 16, 2023
https://attendee.gotowebinar.com/register/981505324428O278

"I mean, what if we just come out and say that we have no idea what the weather will be?"

What Can We Do About It?

Mitigation

Reducing greenhouse gas emissions &/or removing carbon dioxide from the atmosphere can lessen the severity of climate change & its impacts.



Adaptation

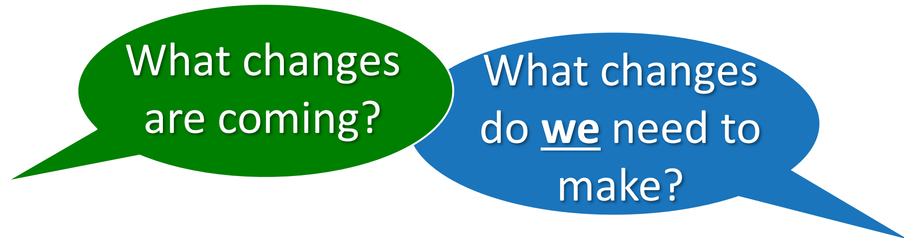
Improving our ability to cope with or avoid harmful impacts; or taking advantage of newly favorable conditions. Reducing risk and vulnerability, and exploiting opportunities.

Mitigation: reducing CO_2 in the atmosphere

- Develop new habits to avoid wasting energy
- Switch to carbon-free energy sources, such as solar & wind
- Plant trees to increase the amount of CO_2 taken up by forests & to reduce severity of 'urban heat islands'
- Establish a carbon tax /dividend to build the cost to pollute into the economy
- Pay ag. for conservation

Assessing a region's ability to handle sea level rise and flooding

Adaptation: Anticipating & adjusting to new conditions



- Install green roofs or reflective roofs
- Develop infrastructure to manage water extremes
- Plant different crops
- Develop new business models
- Make assets & supply chains more resilient

Thank You

Doug.kluck@noaa.gov

www.ncei.noaa.gov

NCEI Climate Facebook: http://www.facebook.com/NOAANCEIclimate
NCEI Ocean & Geophysics Facebook: http://www.facebook.com/NOAANCEIoceangeo
NCEI Climate Twitter (@NOAANCEIclimate): http://www.twitter.com/NOAANCEIclimate
NCEI Ocean & Geophysics Twitter (@NOAANCEIocngeo): http://www.twitter.com/NOAANCEIocngeo